(Hello World)

THE MAGAZINE FOR COMPUTING & DIGITAL MAKING EDUCATORS

THE CHROMEBOOK GENERATION
Advancements in tech risk passive consumers

CURIOSITY-LED DATA LITERACY
Data skills to create empowered citizens

TEACHING THE IMPACT OF TECH
Broadening the topics of your computer lessons

Issue 24 | Jul 2024 | helloworld.cc

IMPACT *OF* TECH

PLUS **OCTOSTUDIO** · NEW MICRO:BIT PROJECTS · **CODING FOR CLIMATE CHANGE** · CYBERSECURITY MEET THE CODE CLUBS · **ADA COMPUTER SCIENCE** · VENEZUELA'S FIRST MAKERSPACE · **BEBRAS STUDENTS AND AI** · INCLUSIVE DESIGN PRINCIPLES · **CREATIVE CAREERS** · HYBRID REMOTE LEARNING

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HELLO, WORLD!

When the iPad was first released in 2010, I was tasked by a forward-thinking publisher to create the first Peppa Pig e-book app. The goal was to deliver the best digital book experience possible for children and families, in the fastest time — but we didn't know what digital illustrated books were like, because they hadn't existed before.

I had totally forgotten about that experience until now, working on this issue of Hello World. It's hard to remember a time when iPads and tablets didn't exist. That's how technology impacts us — the confusion and scramble from 'Why do I need that' to 'I can't live without it' to 'That's just how it's always been.'

In this issue, on pages 20–21, Mitchel Resnik and Natalie Rusk share their new project, OctoStudio — a coding app for mobile phones without the need for network connection. OctoStudio is broadening access to coding by meeting communities where they're at — on mobile phones, without access to the internet. On pages 40–41, Ben Hall discusses whether technology is divisive or inclusive, and how we can encourage students to think critically about it. Finally, on page 80, Petar Simonovic will help you think critically in his review of *The Coming Wave* by Mustafa Suleyman, DeepMind co-founder and CEO of Microsoft AI.

With AI, we are in the midst of our own wave of innovation, and what better way to help young people navigate it than to support them in thinking critically about the impact of technology in their lives?

Meg Wang
Editor

FEATURED THIS ISSUE

JASMEEN KANWAL

Jasmeen and the team at Data Education in Schools share their resources to help young people start to learn the skills they need to change the world with data. Pages 24–26.

YOLANDA PAYNE

Yolanda is using teaching experiences from the Covid pandemic to bring a better version of remote learning to communities in Georgia in the US and in the US Virgin Islands. Pages 28–29.

JULIE YORK

Julie teaches CSed in Maine, in the US. On pages 34–35, read Julie's thoughts on how incorporating AI education into any classroom can help students prepare for future careers.

(HW)

Hello World is the official magazine of the Raspberry Pi Foundation

Raspberry Pi Foundation

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(HW) CONTENTS

NEWS, FEATURES, AND OPINION

CELEBRATING CREATIVITY: THE BEST MOMENTS FROM COOLEST PROJECTS 2024

Sophie Ashford

COOLEST PROJECTS IRELAND

The Coolest Projects Ireland event celebrated young digital tech creators at Dublin City University, St Patrick's Campus on Saturday, 13 April. The event saw 100 young people share over 90 incredible projects, highlighting their creativity and coding proficiency.

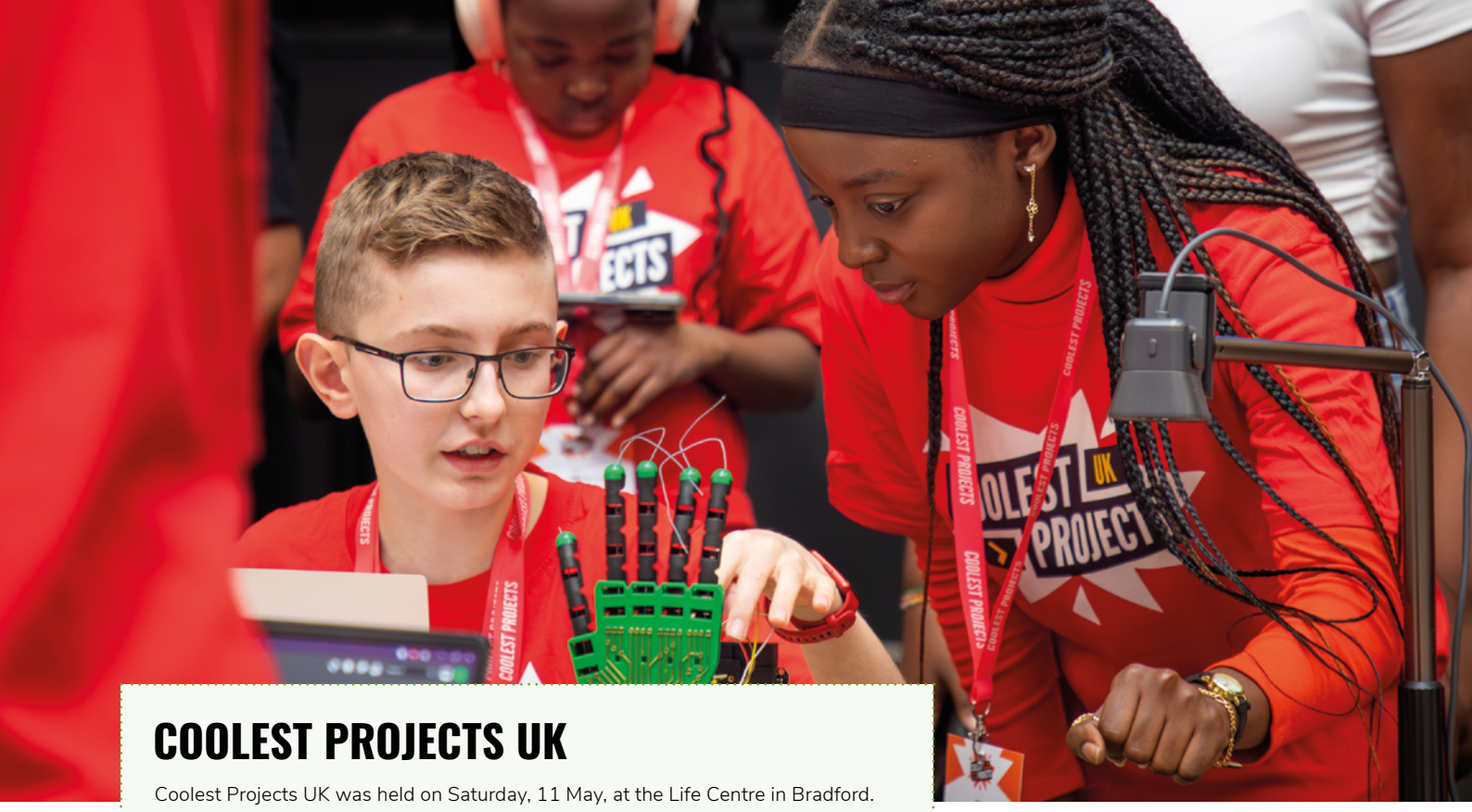
Isabel showcased her app, HerSportsHub, aimed at getting more girls into sports.

VIP judges get to grips with the projects on show and give feedback on taking them to the next level.

There were six categories on show: Scratch, Games, Web, Mobile Apps, Advanced Programming and Hardware.

Young creators celebrate at the awards ceremony.

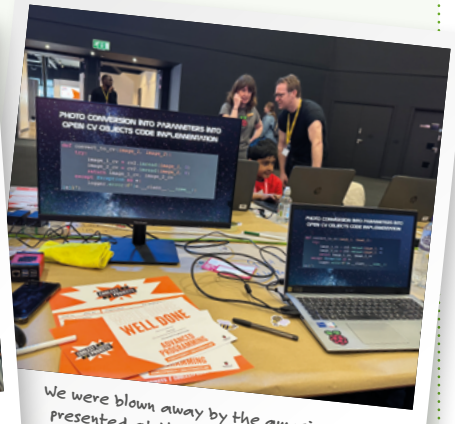
Participants get set up for a fun day at Dublin City University, St Patrick's Campus



COOLEST PROJECTS UK

Coolest Projects UK was held on Saturday, 11 May, at the Life Centre in Bradford. Over 70 children joined in the fun, showcasing a variety of projects, from a website aimed at tackling period inequality to a brother–sister duo presenting their journey with the Astro Pi Challenge.

Friend of the Foundation, Jay, showcased his project MARS-Pi.



We were blown away by the amazing projects presented at the Life Centre in Bradford.

Greg Foot joined the day as host, meeting young creators and keeping everything on track.

Judges from the Foundation, Amazon Future Engineer, and the community encourage creators on their coding journey.

Coolest Projects is a celebration of young digital creators and the amazing things they make with technology. There's a global online showcase each year, and in-person events also take place in several countries.

This year, the online showcase and events in the UK and Ireland were organised by the Raspberry Pi Foundation. Further in-person Coolest Projects events run by partner organisations are being hosted in various countries, including Sri Lanka and Ghana.

Welcoming projects of all kinds, from big to small, from beginner to advanced, and from works in progress to completed creations, Coolest Projects is an opportunity for a community of like-minded young people to come together and celebrate a shared passion for all things computer science, and provides a fun way of encouraging participation in STEM activities.

In-person events give the team the chance to engage with young creators locally, and this year's events in Dublin, Ireland, and Bradford, UK, were certainly days to remember. Check out some of the highlights. (HW)

We will be celebrating all entries to the online showcase in a live celebration on 26 June. You can find out more about the celebration, or sign up to the newsletter to be the first to hear about taking part next year, on the Coolest Projects website: ***rpf.io/cpinfo****.*

NEW CODE EDITOR FEATURES FOR TEACHING

Coming soon: Create coding activities and share them with students in the Code Editor

Phil Howell and Mel Farrington

Last year we released our free Code Editor (editor.raspberrypi.org) and made it available as an open-source project. Right now we're developing a new set of features to help schools use the Editor to run text-based coding lessons online and in-person.

The new features will enable educators to create coding activities in the Code Editor, share them with their students, and leave feedback directly on each student's work. In a simple and easy-to-use interface, educators will be able to give students access, group them into classes within a school account, and quickly help with resetting forgotten passwords.

Teach text-based coding in the classroom for free

We're adding these teaching features to the Code Editor because one of the key problems

The Code Editor is designed for ages nine and up

we've seen educators face over the past few months has been the lack of an ideal tool to teach text-based coding in the classroom. There are some options available, but the cost can be prohibitive for schools and educators. Our mission is to support young people to realise their full potential through the power of computing, and we believe that to tackle educational disadvantage, we need to offer high-quality tools and make them as accessible as possible. This is why we'll offer the Code Editor and all its features to educators and students for free, forever.

Alongside the new classroom management features, we're also working on improved Python library support for the Code Editor, so that you and your students can get more creative and use the Editor for more advanced topics. We continue to support HTML, CSS, and JavaScript too, so you can set website development tasks in the classroom.

Educators have already been incredibly generous in their time and feedback to help us design these new Code Editor features, and they've told us they are excited to see the upcoming developments.

Pete Dring, head of computing at Fulford School in York, participated in our user research and commented on LinkedIn: "The class management and feedback features they're working on at the moment look really promising."

> "OUR MISSION IS TO SUPPORT YOUNG PEOPLE TO REALISE THEIR FULL POTENTIAL

Lee Willis, head of ICT and computing at Newcastle High School for Girls, also commented on the Code Editor: "We have used it and love it, the fact that it is both for HTML/CSS and then Python is great as the students have a one-stop shop for IDEs."

Get started

We're working to have the Code Editor's new teaching features ready later this year. We've recently launched the set-up journey, so that you can pre-register for your school account as we continue to work on these features. Find out more at: **editor.raspberrypi.org/en/education**.

The Code Editor is already being used by thousands of people each month. If you'd like to try it, you can get started writing code right in your browser today, with zero set-up. (HW)

OUR COMMITMENT TO YOU

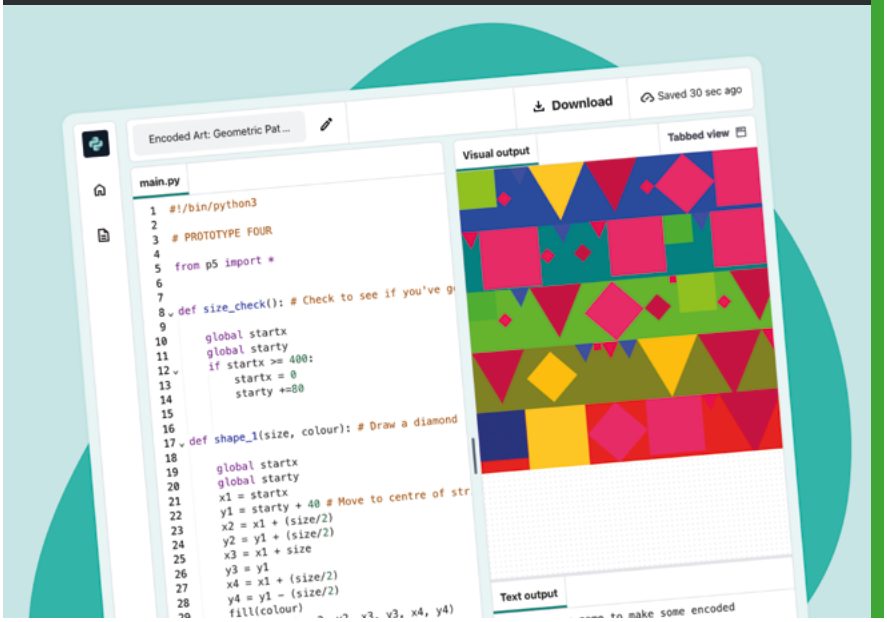
Free forever
We will always provide the Code Editor and all of its features to educators and students for free.

A safe environment
Accounts for education are designed to be safe for students aged nine and up, with a focus on safeguarding.

Privacy first
Student data collection is minimised and all collected data is handled with the utmost care, in compliance with GDPR and the ICO Children's Code (**helloworld.cc/ICOchildrenscode**).

Best-practice pedagogy
We'll always build with education and learning in mind, backed by our leading computing education research (**raspberrypi.org/research**).

Community-led
We value and seek out feedback from the computing education community so that we can continue working to make the Code Editor even better for teachers and students.



NEW MICRO:BIT PROJECT PATH FOR KIDS!

Young people can learn to code and create with our path of micro:bit coding projects

Pete Bell

As you probably know, a micro:bit is a small, programmable device designed for education. You can program it using any computer. It's easy to use and learn with, and suitable for beginners, especially young people, both in and out of school. Using the sensors, buttons, and lights featured on the micro:bit, you can make the interactive projects in our 'Intro to micro:bit' path. By the end of this path you will have used your new skills to create a party game to play and share with your friends.

A well-being theme

Our free 'Intro to micro:bit' path of projects focuses on well-being, including topics like mental health, relaxation, and exercise (**helloworld.cc/microbitintro**). Our aim with this new micro:bit project path is to help young people explore how they can create their own tech tools to help them look after themselves and others.

Projects in the 'Intro to micro:bit' path focus on well-being

The six micro:bit coding projects in our new path all cover different aspects of well-being in a fun, creative way:

1. Good sleep patterns
2. Relaxation
3. Self-confidence
4. Happiness
5. Health
6. Entertainment

We hope that following the path and making the projects will encourage learners to ask questions, share their experiences, and feel that they can ask parents, teachers, or mentors for support, as well as helping to support their friends and peers.

3, 2, 1, make!

The 'Intro to micro:bit' path is designed according to our Digital Making Framework (**helloworld.cc/digital-making**). The structure of the path leads learners through the development process of a coding project and shows them how to turn their ideas into reality. The path structure also supports them with fixing programming errors (debugging), showing them that errors are a normal part of computer programming, and temporary setbacks that they can overcome. Because community is important for learning, the path also offers young people the chance to share the projects they make with peers around the world. Read more about our Digital Making Framework in our mentor guide (**helloworld.cc/321make**).

Three Explore projects guide learners through tasks that introduce them to new coding skills.

Next, learners complete two Design projects to practise their skills and personalise their creations.

Finally, learners complete one Invent project, in which they consolidate everything they have learnt so far, to create something unique that matters to them.

Explore projects

MUSIC PLAYER Program the micro:bit to play melodies that can improve your mood, and create code so the buttons and accelerometer can control playback.

SOUND LEVEL METER Make the micro:bit display how noisy your environment is, and save the noise data to identify the noisiest times in your day.

SLEEP TRACKER Create a program to track your sleep movements using the micro:bit's accelerometer, and display sleep data on the LEDs.

Design projects

HOW'S YOUR DAY? Get creative and build a mood checker program.

Credit: © David Bird

> USE YOUR NEW CODING SUPERPOWERS TO RECREATE YOUR FAVOURITE PARTY GAME FOR FUN AND RELAXATION

Choose the outputs according to the user's replies, display an animation or positive message, or play music.

ACTIVE ASSISTANT Be inspired to get active! Example projects include a step counter, a hang timer (for upper body strength), and a bleep test (remember those?).

Invent project

PARTY GAME Use your new coding superpowers to recreate your favourite party game for fun and relaxation with your friends and family.

We have written these micro:bit coding projects with young people between the ages of six to thirteen in mind.

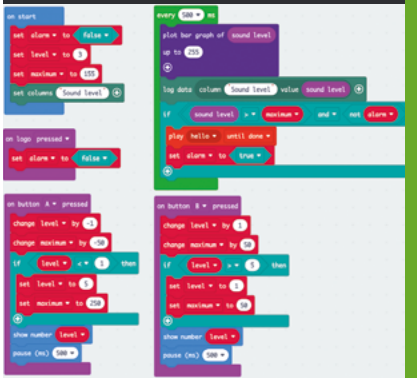
Building the projects on the path does not require any previous coding experience, although complete beginners to coding may find it useful to work through our free 'Introduction to Scratch' path first (**helloworld.cc/scratchintro**).

If you're looking to get started with our micro:bit path, there is lots of support available to you. Our 'Getting started with micro:bit' guide has information and tips to help you use the micro:bit projects with your clubs and classrooms (**helloworld.cc/microbit-guide**). (HW)

CODING SKILLS

The key programming concepts covered are:

- Variables
- Using selection ('if', 'else if', and 'else')
- Using repetition ('for' loops)
- Using randomisation
- Using functions



ada computer science

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- Save time when planning lessons and marking work
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Raspberry Pi Foundation

UNIVERSITY OF CAMBRIDGE

ADA COMPUTER SCIENCE

A free, comprehensive tool for computer science educators and independent learners aged 14–19

Diane Dowling

We often receive enquiries about Ada Computer Science and how it stands out from other learning products. First and foremost, Ada Computer Science is a collaborative initiative between the Raspberry Pi Foundation and the University of Cambridge. The same partnership is behind the Raspberry Pi Computing Education Research Centre (computingeducationresearch.org), providing us with access to the latest research in computer science education.

An interactive CS textbook

Ada Computer Science is a free website that can be thought of as an extensive and interactive computer science textbook. Our topics are mapped to the Raspberry Pi Foundation's *Big Book of Computing Content* (**helloworld.cc/BBCC**), and you can find a wide range of subjects within each strand of computer science. Our concept pages cover all the learning objectives for typical GCSE (ages 14–16) or A-level (ages 16–19) programmes of study in England. We take pride in providing content that has both depth and breadth, making Ada Computer Science a trustworthy one-stop shop for computer science educators and independent learners.

Evolving feedback

There are more than 1,100 self-marking questions on Ada Computer Science. These use a wide range of formats and provide feedback for incorrect answers. Every month, our content team — made up of experienced educators with many years of classroom experience — reviews a report of all incorrect answers that lack feedback. We analyse why learners might have given these answers and then create new feedback, ensuring that future learners who make the same mistakes receive specific guidance to inform their learning.

Practise free-text answers

We are currently developing a tool to mark questions with free-text answers. This has long been a priority for us, as most exams in the UK assess theoretical knowledge in this way. Over the past six months, we have collaborated with the University of Cambridge to develop a tool that uses a large language model. We have just received approval from the University of Cambridge ethics committee to use it on the site. This ensures that learners receive feedback that adheres rigorously to the principles of fairness, accountability, and transparency.

Real code examples

There are hundreds of code examples across the site. These examples are presented first in pseudocode and then in four programming languages: Python, C#, Java, and Visual Basic (VB). Each example includes a link to GitHub, where a complete version can be downloaded and run. We use a coding style with meaningful identifiers, and we avoid complex statements to make our code easy to follow. For databases and SQL, we offer a range of scenarios and a complete project that students can follow. Our built-in SQL editor allows students to run their queries online against our sample databases.

All of our content is mapped to a wide range of exam board specifications. This allows signed-in users to customise their experience by viewing only the content relevant to their exam board. When we adopt a new specification, we first map our existing content to it, and then we create any additional content that is needed. All of our content undergoes a rigorous quality assurance process, and a feedback button on every page allows users to flag errors. We take pride in promptly addressing any issues that are reported.

If you haven't used Ada Computer Science yet, why not give it a try now? It is completely free, and by creating an account, you can set your viewing preferences. Additionally, if you are a teacher, you can assign work to your students without the need to mark it yourself (**adacomputerscience.org**). (HW)

We invited teachers to our offices to create their own questions for the Ada platform; these questions will be published soon

COLUMN

DESIGNING FOR INCLUSION IN COMPUTING PROJECTS

Do you teach all of your students about the impact of technology on people with special educational needs and disabilities and other learning needs? Do learners consider inclusive design principles when planning out their own projects?

An important part of teaching the subject of computing is to make young people aware of the implications of using technology — the impact upon society and individuals of how systems, hardware, and software are used and designed.

I have written a great deal about the benefits of technology to support learners with a range of additional learning needs and physical disabilities. The development of tablets and smartphones, together with rapid advances in artificial intelligence, have made incredible differences to individuals: non-verbal children can use mainstream devices to communicate more effectively; people with physical disabilities can control their physical environment using their voice; text-to-voice tools built into everyday applications allow visually impaired learners to access the same content as their peers.

To what extent are all students aware of the opportunities and solutions offered by digital technologies to solve accessibility issues, not just to support their own learning, but to develop their thinking about how we design applications and computing systems, and who should be involved in the decision-making process as tools are developed? Most large companies include accessibility as a core tenet of their design of new products. Microsoft, for example, builds inclusive design principles into everything it creates — the idea being that by recognising where exclusion happens and gaining insights from a diverse range of people, we can design products that solve a particular problem but also benefit everyone. So, voice-to-text tools support a learner with a physical disability or dyslexia to write, but also aid the student with a broken arm, or the person who prefers to take notes as they walk.

As teachers, we have a responsibility to provide opportunities for discussion around accessibility and inclusion. When we introduce projects, we should enable students to use inclusive design principles in their planning and raise awareness of the different needs of users. Every time learners design a product or application, do they also consider the customisations that could be included to make it more accessible?

There are a large number of tools, case studies, and videos on the Microsoft website that you can use in the classroom to teach about inclusive design: see **inclusive.microsoft.design**. For example, the Inclusive Activity Cards provide a number of prompts and product design activities, taking into account how we can learn from the expertise of people who experience disability or exclusion on a permanent basis, and considering the detail in a sequence of interactions with technology to find ways to make the interactions more inclusive. How might you use this resource in your classroom?

Catherine Elliott leads the Sheffield eLearning Service (**sheffieldclc.net**) and has spent a number of years working on ways to make computing accessible for all learners. She is co-chair of the CAS Include working group, and leader of the Sheffield and South Yorkshire Secondary and Virtual SEND CAS Communities (**@catherinelliott**).

Project ideas

Teachers can also provide a range of project ideas to challenge students to solve specific problems. Below are some ideas you could use in your computing lessons:

Communication aid

Design and create a communication aid for a non-verbal young person who needs support to express themselves about a specific area of communication, for example making decisions or talking about likes and dislikes. There are a number of ways to do this:

- Use action buttons or images linked to audio recordings in PowerPoint
- In Scratch, use the text-to-audio extension (**helloworld.cc/CommunicationAidExample**)
- Use the speech synthesiser in micro:bit with Python to add speech to specific gestures or inputs; see the image in this article for sample code

Accessible game control

Consider how a young person with a physical disability might control a game or robot, and build accessible controllers or alternative input methods:

- Use a Makey Makey (**makeymakey.com**) or the micro:bit pins to create accessible controllers using conductive materials, e.g. Play-Doh or foil-covered cardboard
- Explore the Teachable Machine, which uses machine learning to recognise human gestures (**helloworld.cc/GestureControlledRobot**)
- Use the video sensing extension in Scratch to enable a user to play a game using motion sensed through a webcam; there are some examples in the studio here: **helloworld.cc/MotionSensingGames**

Impact of artificial intelligence

- Research a presentation on a range of tools to support learners with additional learning needs using artificial intelligence
- Explore how to write an effective prompt in a generative AI tool in order to create a personal assistant that can support a learner with poor executive function (the skills we use to help us set goals, plan, and get things done) to complete project work

```python
# Import speech
from microbit import *
import speech

while True:
    if button_a.was_pressed():
        display.show(Image.YES)
        speech.say('Yes')
        sleep(1000)
        display.clear()
```

Sample code to use the speech synthesiser in micro:bit with Python

> DO YOUR STUDENTS CONSIDER INCLUSIVE DESIGN PRINCIPLES?

- Complete the unplugged activities about AI from Barefoot Computing's new AI Explorers collection (**helloworld.cc/ai-explorers**) and discuss how bias can be built into data that computer systems are trained on

Inclusive design

- Paper-prototype or build an app to meet a specific need, for example, to show users the location of accessible toilets. How will users interact with the app? What customisations can you add to help with accessibility?
- When designing a website, ask students to present their ideas on customisations that can be included to make their web pages more accessible to a diverse range of users, such as a high-contrast version, built-in text-to-voice capability, or the ability to change the text size.

So next time you are introducing a project to your students, consider how you can encourage them to think about the impact of what they are creating, and support them to incorporate inclusive design principles into their design process. It would be great to hear about your ideas for inclusive projects; share them at **@HelloWorld_Edu** or **contact@helloworld.cc**. (HW)

#INSIGHTS

A TOOL TO FIND SCRATCH PROGRAMMING ERRORS

STORY BY Bonnie Sheppard

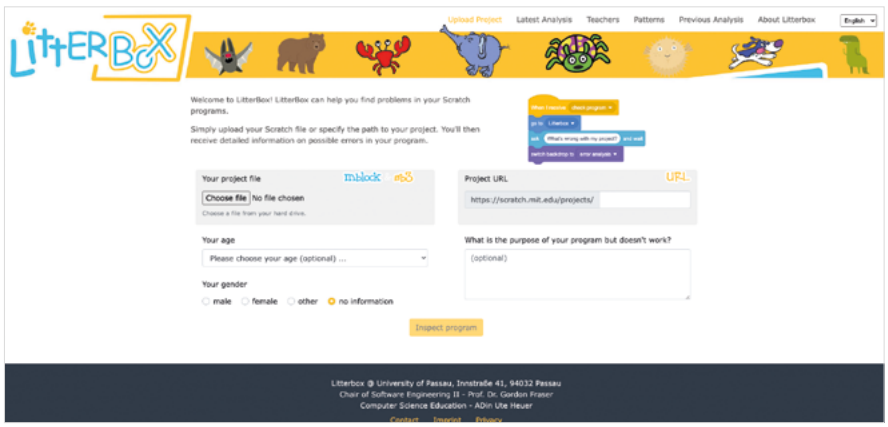
We all know that learning to program, and specifically learning how to debug or fix code, can be frustrating and leave beginners overwhelmed and disheartened. But what about teachers who are coding novices themselves?

In many countries, primary-school teachers are holistic educators and often find themselves teaching computing despite having little or no experience in the field. In a seminar from our series on computing education for primary-aged children (ages 5–11), researcher Luisa Greifenstein told attendees that struggling with debugging and negative attitudes towards programming were among the top ten challenges mentioned by teachers (**helloworld.cc/teachers-perspectives**).

Luisa is a researcher at the University of Passau, Germany, and has been working closely with both teacher trainees and experienced primary-school teachers in Germany. She's found that giving feedback to students can be difficult for primary-school teachers, and especially for teacher trainees, as programming is still new to them. Luisa's seminar introduced a tool to help.

Visualising debugging with LitterBox

To address this issue, the University of Passau developed a tool called LitterBox (**helloworld.cc/litterbox**). LitterBox offers a unique solution to debugging and was specifically designed for Scratch, a beginners' programming language widely used in primary schools.



You can upload Scratch program files to LitterBox to analyse them

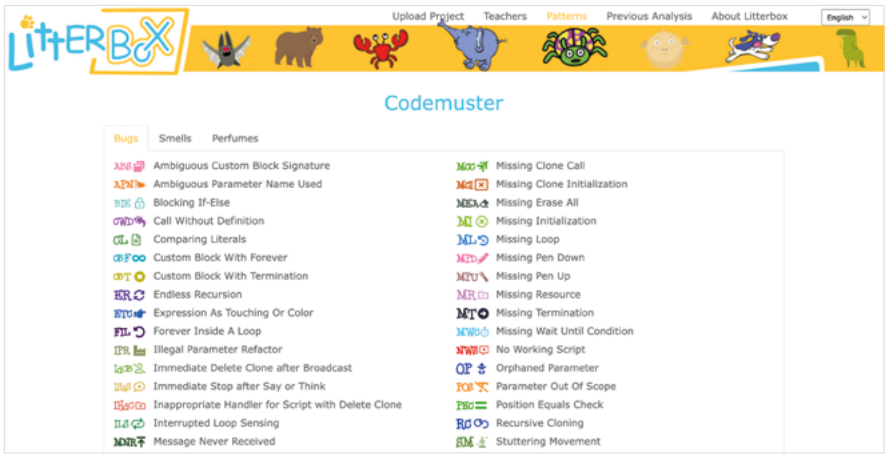
LitterBox serves as a static code debugging tool that transforms code examination into an engaging experience. With a nod to the Scratch cat, the tool visualises the debugging of Scratch code as checking the litter box, categorising issues into 'bugs' and 'smells':

- Bugs represent code patterns that have gone wrong, such as missing loops or specific blocks
- Smells indicate that the code couldn't be processed correctly because of duplications or unnecessary elements

What sets LitterBox apart is that it also rewards correct code by displaying 'perfumes'. For instance, it will praise correct broadcasting or the use of custom blocks. For every identified problem or achievement, the tool provides short and direct feedback.

Luisa and her team conducted a study to gauge the effectiveness of LitterBox. In the study, teachers were given fictitious student code with bugs and were asked to first debug the code themselves, and then to explain in a manner appropriate to a student how to do the debugging.

The results were promising: teachers using LitterBox outperformed a control group with no access to the tool. However, the team also found that not all hints proved equally helpful. When hints lacked direct



The code patterns that LitterBox recognises

relevance to the code at hand, teachers found them confusing, which highlighted the importance of refining the tool's feedback mechanisms.

Despite its limitations, LitterBox proved helpful in another important aspect of the teachers' work: coding task creation. Novice students require structured tasks and help sheets when learning to code, and teachers often invest substantial time in developing these resources. While LitterBox does not guide educators in generating new tasks or adapting them to their students' needs, in a second study conducted by Luisa's team, teachers who had access to LitterBox not only received support in debugging their own code, but also provided more scaffolding in task instructions they created for their students compared to teachers without LitterBox.

How to maximise the impact of new tools

One important realisation that we had in the Q&A phase of Luisa's seminar was that many different research teams are working on solutions for similar challenges, and that the impact of this research can be maximised by integrating new findings and resources. For instance, what the LitterBox tool cannot offer could be filled by:

- Pedagogical frameworks to enhance teachers' lessons and feedback structures. Frameworks such as PRIMM (Predict–Run–Investigate–Modify–Make) or TIPP&SEE (Title–Instructions–Purpose–Play–Sprites–Events–Explore) for Scratch projects can be valuable resources (**helloworld.cc/primm, helloworld.cc/tipp**). These frameworks provide a structured approach to lesson design and teaching methodologies, making it easier for teachers to create engaging and effective programming tasks. Additionally, by adopting semantic waves in the feedback for teachers and students, a deeper understanding of programming concepts can be fostered (**helloworld.cc/semantic-waves**).
- Existing courses and materials to aid task creation and adaptation. Our expert educators at the Raspberry Pi Foundation have created not only free lesson plans and courses for teachers and educators (**raspberrypi.org/teach**), but also dedicated non-formal learning paths for Scratch, Python, Unity, web design, and physical computing that can serve as a starting point for classroom tasks (**helloworld.cc/learning-paths**).

Exploring innovative ideas in computing education

As we navigate the evolving landscape of programming education, it's clear that innovative tools like LitterBox can make a significant difference to the journeys of both educators and students. By equipping educators with effective debugging and task creation solutions, we can create a more positive and engaging learning experience for students.

If you're an educator, consider exploring how such tools can enhance your teaching and empower your students in their coding endeavours. You can watch the recording of Luisa's seminar here: **helloworld.cc/LitterBox-seminar**. (HW)

> LITTERBOX OFFERS A UNIQUE SOLUTION TO DEBUGGING AND WAS SPECIFICALLY DESIGNED TO BE USED WITH SCRATCH

Teachers using LitterBox outperformed a control group with no access to the tool

STUDENTS' ATTITUDES TO USING AI TOOLS IN PROGRAMMING EDUCATION

STORY BY Katharine Childs

Educators around the world are grappling with the problem of whether to use artificial intelligence (AI) tools in the classroom (helloworld.cc/ai-in-education). As more and more teachers start exploring ways to use these tools for the teaching and learning of computing, there is an urgent need to understand the impact of their use, to make sure they do not exacerbate the digital divide and leave some students behind.

Sri Yash Tadimalla from the University of North Carolina (**sriyashtadimalla.com**) and Dr Mary Lou Maher, director of research community initiatives at the Computing Research Association (**maryloumaher.net**), are exploring how student identities affect their interaction with AI tools and their perceptions of their use. They presented findings from two of their research projects in our research seminars (**raspberrypi.org/research/seminars**).

How students interact with AI tools

A common approach in research is to begin with a preliminary study involving a small group of participants in order to test a hypothesis, ways of collecting data from participants, and an intervention. Yash explained that this was the approach they took with a group of 25 undergraduate students on an introductory Java programming course. The research observed the students as they performed a set of programming tasks using an AI chatbot tool (ChatGPT) or an AI code generator tool (GitHub Copilot).

The data analysis uncovered five emergent attitudes of students using AI tools to complete programming tasks (**helloworld.cc/AI-attitudes**):

- Highly confident students rely heavily on AI tools and are confident about the quality of the code generated by the tool without verifying it
- Cautious students are careful in their use of AI tools and verify the accuracy of the code produced
- Curious students are interested in exploring the capabilities of the AI tool and are likely to experiment with different prompts
- Frustrated students struggle with using the AI tool to complete the task and are likely to give up
- Innovative students use the AI tool in creative ways, for example to generate code for other programming tasks

Whether these attitudes are common for other, and larger, groups of students requires more research. However, these preliminary groupings may be useful for educators who want to understand their students and how to support them with targeted instructional techniques. For example, highly confident students may need encouragement to check the accuracy of AI-generated code, while frustrated students may need assistance to use the AI tools to complete programming tasks.

Credit: © photo for everything/stock.adobe.com

Students performed a set of programming tasks using either ChatGPT or GitHub Copilot

This preliminary study involved 25 undergraduate students on an introductory Java course

An intersectional approach to investigating student attitudes

Yash and Mary Lou explained that their next research study took an intersectional approach to student identity. Intersectionality is a way of exploring identity using more than one defining characteristic, such as ethnicity and gender, or education and class (**helloworld.cc/intersectionality**). Intersectional approaches acknowledge that a person's experiences are shaped by the combination of their identity characteristics, which can sometimes confer multiple privileges or lead to multiple disadvantages.

In this second research study, 50 undergraduate students participated in programming tasks and their approaches and attitudes were observed. The gathered data was analysed using intersectional groupings, such as:

- Students who were from the first generation in their family to attend university and female
- Students who were from an underrepresented ethnic group and female

Although the researchers observed differences among the groups of students, there was not enough data to determine whether these differences were statistically significant.

> WHEN ASKED WHETHER USING AI TOOLS IN PROGRAMMING WAS CHEATING, MORE PRIVILEGED STUDENTS AGREED THAT IT WAS

Who thinks using AI tools should be considered cheating?

Participating students were also asked about their views on using AI tools, such as 'Did having AI help you in the process of programming?' and 'Does your experience with using this AI tool motivate you to continue learning more about programming?'

The same intersectional approach was taken towards analysing students' answers. One surprising finding stood out: when asked whether using AI tools to help with programming tasks should be considered cheating, students from more privileged backgrounds agreed that this was true, while students with less privilege disagreed and said it was not cheating.

This finding comes from a very small group of students at a single university, but Yash and Mary Lou called for other researchers to replicate this study with other groups of students to investigate the question further.

You can watch the full seminar here: **helloworld.cc/AI-tools-seminar**.

Acknowledging differences to prevent deepening divides

As researchers and educators, we often hear that we should educate students about the importance of making AI ethical, fair, and accessible to everyone. However, hearing this message isn't the same as believing it. If students' identities influence how they view the use of AI tools, it could affect how they engage with them for learning. Without recognising these differences, we risk continuing to create wider and deeper digital divides. (HW)

OCTOSTUDIO: MOBILISING CREATIVE LEARNING

The Lifelong Kindergarten group from MIT Media Lab introduces a new and easy way to create interactive projects with mobile devices

A group of schoolchildren in Chile walk on a hillside, taking photos of plants and animals with mobile phones and tablets. They then use their photos to create animated stories about the local environment.

At an elementary school in California, students create a variety of games that respond to the shaking and tilting of their tablets. They program characters to jump, score points, and play sounds as classmates interact with their projects.

MITCHEL RESNICK & NATALIE RUSK

Mitchel Resnick is professor of learning research and Natalie Rusk is a research scientist in the Lifelong Kindergarten research group at the MIT Media Lab. For more than 30 years they have collaborated on the design of new technologies and activities to help young people from diverse backgrounds develop as creative, curious, caring, and collaborative learners. They have worked together on the development of Scratch, the Clubhouse Network, OctoStudio, and other initiatives that inspire and support creative learning around the world.

Three students from Vietnam create a collaborative animation of a spaceship travelling from one tablet to another, by programming each tablet to 'beam' a signal to the next.

In all these projects, students were creating with OctoStudio, a new free coding app designed specifically for mobile phones and tablets. With OctoStudio, students can take photos and record sounds, bring them to life with coding blocks, and send their projects to family and friends.

Our Lifelong Kindergarten group at the MIT Media Lab developed OctoStudio to expand the creative learning experiences available to children from diverse backgrounds. Our group previously invented Scratch, the world's most popular coding language for kids.

More and more children around the world now have access to smartphones and tablets, but limited or no access to computers or the internet. OctoStudio transforms mobile devices into platforms for creativity and learning, opening opportunities for more children to design, create, experiment, and express themselves with digital technology.

To support widespread access to OctoStudio, the app is completely free of charge and does not require any network connection to create and save projects. It is available for download on Android and iOS tablets and phones, and includes translation into more than 25 languages.

What can students create?

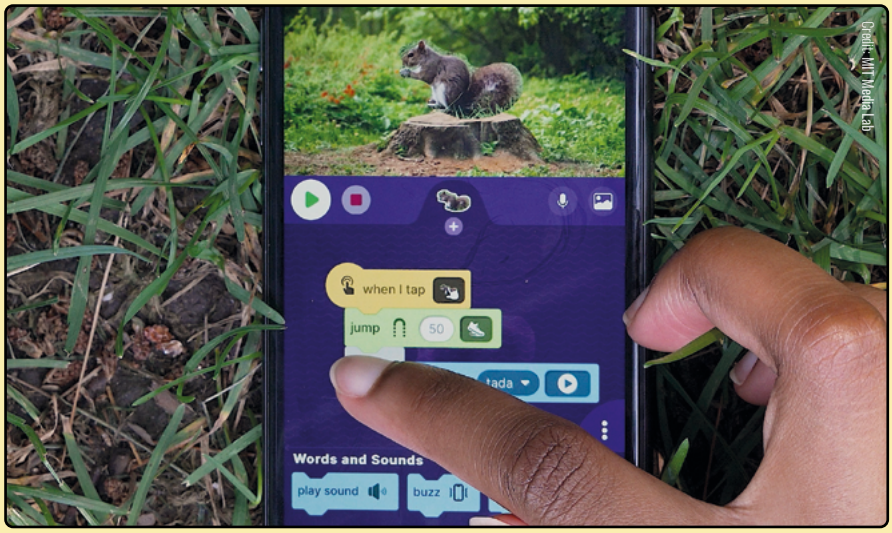
OctoStudio makes it easy for beginners to start creating. Children can choose a character from a diverse collection of emojis, draw their own in the OctoStudio paint editor, or take and edit a photo. With just a couple of coding blocks, they can make their characters move, jump, speak, or glow — and respond to shaking, tilting, or tapping on the phone or tablet.

We've been delighted by the creativity and diversity of projects that students have created with OctoStudio. We designed OctoStudio especially for kids aged seven to twelve, though we've seen people of all ages enjoy creating and sharing projects.

For Earth Day, students in Bragança, Brazil, used OctoStudio to make projects showing ways to protect the environment, featuring animated drawings and photos of animals and plants in their local area, along with messages suggesting how to help support sustainability.

"When the students start to use OctoStudio in the classroom, they become engaged in playful exploration and creative learning," said João Adriano Freitas, a creative coding specialist with the Brazilian Creative Learning Network. "Kids start creating, experimenting, collaborating, and sharing ideas with one another."

Taking advantage of the portability and small size of mobile devices, students and educators have been using OctoStudio to create projects that bridge the gap between the physical and digital worlds. For example, at the Tinkering Studio at the Exploratorium museum in San Francisco, visitors have made houses out of cardboard, then used OctoStudio to program animated scenes that they placed in the windows.



A young person connects coding blocks to animate their OctoStudio project

OctoStudio includes coding blocks that can detect the presence of a nearby magnet. One student created a 'magic wand' by attaching a magnet to the end of a ruler, then programmed an OctoStudio story in which the scene changed whenever someone waved the wand near the tablet.

The 'beam' coding blocks have been especially popular, enabling students to make collaborative projects by sending Bluetooth signals from one device to another. For example, students in a school in Thailand worked on an interactive project in which shaking a watering can on one tablet beamed a message to make a tree grow on another tablet.

Global collaboration

In designing OctoStudio, we collaborated with educators around the world, especially in regions where there is limited or no access to computers, but mobile devices are increasingly available. Educators in Brazil, South Africa, India, Mexico, Uganda, and other countries tried prototypes of the app with young people in their communities, provided feedback, and suggested new images and examples to add to the app, reflecting the interests and cultural experiences of people in their communities.

"It's important for children to be able to create projects that are meaningful and relatable to them, and that reflect their neighbourhoods and surroundings," said Linford Molaodi, lecturer and programme manager of the creative coding project at the University of Johannesburg in South Africa.

Feedback from global partners also led to significant changes to the emoji library that is included in the OctoStudio app. Although the images of people in the standard Unicode emoji library provide a choice of six skin colours, they still lack racial and cultural representation in important ways. Based on feedback and playtesting with partners, our team redesigned more than 200 images of people in the OctoStudio emoji library, including body types, headwear, and hair texture and styles that support a broader representation of racial, cultural, and gender identities.

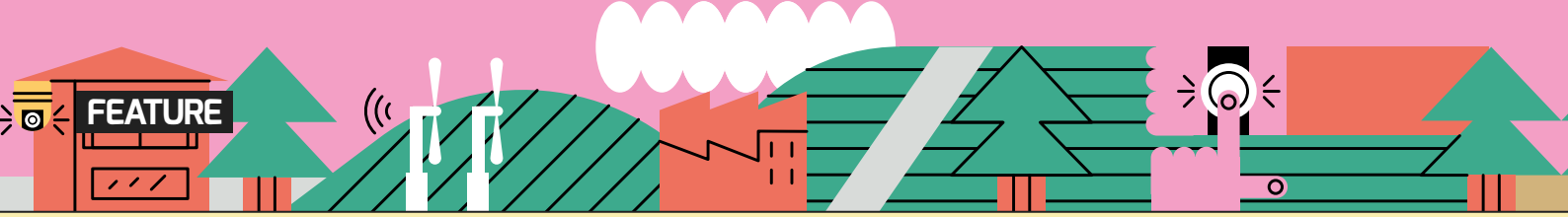
Looking ahead

We designed OctoStudio to support what we call the four Ps of creative learning: projects, passion, peers, and play. That is, our goal is to enable learners to create projects, based on their passions, along with peers, in a playful spirit. We have found that this approach helps young people develop the creativity, curiosity, and communication skills that are so important in today's world.

From our past projects, we've learnt that it's easier to spread an innovative technology than to spread an innovative approach to learning. The future success of OctoStudio will depend not just on the number of downloads, but on how the app is used by educators and children around the world. Our hope is that educators will introduce OctoStudio in a 4P style, supporting young people to build on their interests, express their ideas, and collaborate with others. We look forward to hearing how you are using OctoStudio in your classroom or community. You can post on social media using **@octostudioapp** or **#octostudio** — or email us at **educator@octostudio.org**. You can download OctoStudio and learn more at **octostudio.org**. (HW)

WHAT MAKES OCTOSTUDIO DIFFERENT?

- Create anytime, anywhere, and bring in photos and sounds from the world around you
- Combine digital and physical interaction, using built-in sensors in phones or tablets
- Intuitive for younger children and beginners: each block displays icons and text
- Supports collaboration across devices by using 'beam' blocks
- Works offline without internet access or data
- Accessibility features for blind and visually impaired learners, using screen reader and sound effects to hear and interact with coding blocks
- Mix with craft and other materials to make projects that go beyond the screen



WHY SHOULD WE MAKE TIME TO TEACH THE IMPACT OF TECHNOLOGY?

Sway Grantham explains how broadening the topics of your computing lessons could benefit your learners

As adults, it is easy for us to see the impact technology has had on society and on our lives. Yet when I tell pupils that, within my lifetime, it wasn't always illegal to hold your mobile phone to your ear and have a call while driving, they are horrified. They are living in the now and don't yet have the perspective to allow them to see the change that has happened. However, knowing the impact of technology allows us to learn from previous mistakes, to make decisions around ethical behaviour (such as using a phone while driving), and to critically engage in real-world issues. As teachers, allocating some time to this topic throughout the year can seem challenging, but with a few small changes, the impact might be more than you can imagine.

PRACTICAL TIPS TO GET STARTED

- Use an 'always, sometimes, never' question and get learners to justify their choice, e.g. 'Social media is a great way to connect with people'
- Have a silent debate that aligns with your computing topic, e.g. during an audio editing unit, consider the impact that downloading and streaming music has on those who make music
- Pick a news article — for young learners you could use news aimed at children — and have learners highlight which bits they want more information about and why

Stepping away from the devices

As teachers know, some computing lessons work best without the students using devices, whether it is a matter of designing their program before they start to code it, creating a map of the school network, or discussing the implications of bias in AI training models. However, students often seem to resent these lessons and feel a sense of betrayal that the subject is not living up to its name. It is important that learners recognise that computers are tools — sometimes they allow us to do and achieve great things, but at other times, there are other approaches that are more suitable. Spending time discussing the impact of technology can help learners decide for themselves when technology is an asset, and when it is a burden.

Another advantage of changing the format of your computing lessons is that they may appeal to a different range of students. While some students may not be interested in using technology, they may be interested in debating ethics, discussing world events, or finding solutions to real-world problems. This allows you to see different learners thriving in your computing lessons, as well as showing the class that lots of different skill sets are needed in the computing industry. In addition, these open, discussion-based lessons can have a net positive impact on how much learners take these issues more into consideration in subsequent lessons. This could include how they design their program, what features they build into a website, or how they structure a database.

Real-world events

Children occupy an interesting place in the world when it comes to world events. Often they seem uninterested, or just can't comprehend what it means to them if someone in a country on the other side of the world makes a law to ban a piece of technology. However, even without engaging in current affairs and watching the news, they pick up information from adults talking and from the snippets they hear and see online or on television, and they try to make sense of it. The problem is that if we don't talk to young people about what they're hearing, they often fill in the blanks incorrectly. Before you know it, they will be anxious that AI will take over the world and that adults hate TikTok for no reason.

At the time of writing, the technology news headlines are around the US threatening to ban TikTok and whether other countries will follow suit; a self-help article about why muting people on social media will change your life; and an Ofcom report which states that a quarter of five- to seven-year-old children in the UK own their own smartphone. Each of these could make a brilliant Impact of Technology

lesson or activity, allowing your learners to become critical thinkers, to consider their own opinions, and to apply what they know about how technology works. From a silent debate as you take the register, to a lesson in which the learners engage in topics they're passionate about — such as social media usage — engaging learners in this way encourages them to articulate what they know and apply it to real-world situations benefitting them, society, and their computing education.

Having difficult conversations

The role of a computing teacher is often broad, from tech support (including changing the ink in the printers) to dealing with safeguarding incidents that happened between pupils at the weekend — and that's before we even get to curriculum and teaching responsibilities. Unfortunately, the more knowledgeable members of staff in a school/department have to be able to deal with a lot of different problems. Effective safeguarding provision means you have to be prepared with a lesson or content to deal with a WhatsApp group gone awry, a social media image that shouldn't have been shared, or a game becoming popular which students are not old enough to play. These lessons should be responsive to the current needs, sometimes even to an emergency response, and they cannot easily be planned in advance. However, teaching Impact of Technology equips students with the skills that you need to have these conversations.

Each of these scenarios are examples of the Impact of Technology on our lives. If students know how to have different opinions, how to talk and listen to each other, and how to imagine different perspectives on an issue, it will be easier when you need to have similar conversations in a more personal context. Equally, for you as the teacher, you will have practised navigating the tension between legality, rules from home, and 'best practice' advice. You will also have lessons that you can refer back to: 'Remember when we were discussing the TikTok ban? How might some of those conversations relate to this situation? What about when we discussed when to block people on games or on social media? Would that be appropriate here?'

Technology is going to continue to impact the lives of the pupils we work with, whether they can recognise that or not. Increasing their awareness of the impact technology is having, in both positive and negative ways, enriches your lessons, shows that content is relevant to learners, and helps protect them when they have to make their own critical decisions.

There are suggestions in this article to use with learners of all ages, but if you want more support on how to teach the topic with older learners, we have an online course for educators (**helloworld.cc/impactoftech**) and a unit of work for 14-year-olds (**helloworld.cc/ks4impact**). (HW)

Computing teachers often have to be prepared with a lesson to deal with safeguarding incidents, such as a Whatsapp group gone awry

> "INCREASING LEARNERS' AWARENESS OF THE IMPACT OF TECHNOLOGY, IN BOTH POSITIVE AND NEGATIVE WAYS, ENRICHES YOUR LESSONS

SWAY GRANTHAM

Sway is a senior learning manager at the Raspberry Pi Foundation, where she leads the educator development team developing resources and training for computing teachers around the world (**@SwayGrantham**).

A CURIOSITY-LED APPROACH TO DATA LITERACY

Jasmeen Kanwal and the **Data Education in Schools team** share data literacy resources

In a village west of Edinburgh, students from Addiewell Primary School race around their local zoo, trying to decide which animal enclosure they think would be most interesting to compare to the environmental conditions in their own classroom. Much to the dismay of Tommy Lawson, who leads the Internet of Things (IoT) in Schools project installing smart sensors in schools across South East Scotland, they decide on the crocodile enclosure. Tommy must assist the zookeeper to carefully install a sensor identical to one the children have in their own classroom, without disturbing Bob and Bindi, the zoo's dwarf crocodiles.

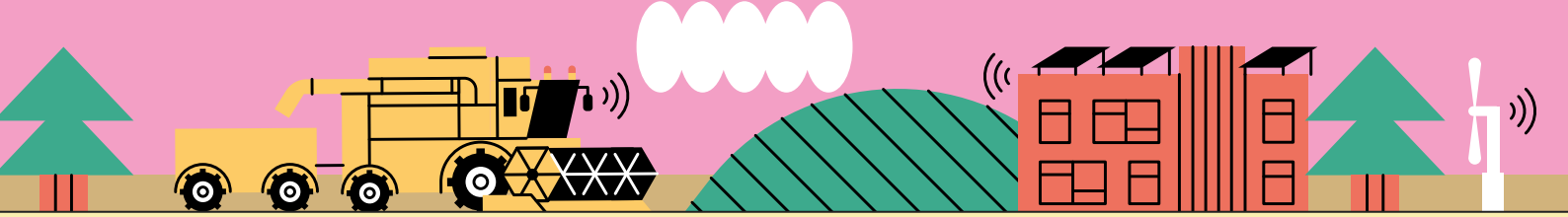
The students had just completed a project investigating the ideal environmental conditions for learning in their classroom, and discovered that when CO_2 levels were too high, they felt sleepy, and that by adding plants to their classroom, they could lower the CO_2 levels. It had been their idea to explore next whether the optimal conditions for humans differed from those for other animals. The technology enabling these discoveries was given to the school by the IoT in Schools network, as part of a £9m investment that will see 500 schools in the South East Scotland region installed with cutting-edge data-gathering devices. This is part of a wider government-funded initiative based at the University of Edinburgh — the Data Education in Schools project — which aims to promote data literacy across the Scottish curriculum by using a curiosity-led learning approach.

Tommy Lawson and students from Addiewell Primary School check their smart sensor placed inside the crocodile enclosure at Five Sisters Zoo in Scotland

Creating empowered citizens

Data skills are to the twenty-first century what reading and writing were to the twentieth. The digital technology revolution has put data at the core of many things, from personal privacy and public health, to effectively running businesses and tackling the climate crisis. If we are to adequately equip all citizens with data skills, the school curriculum is a good place to start. Indeed, data literacy is considered to be one of the core foundations for the Organisation for Economic Co-operation and Development's (OECD) 2030 Learning Compass, alongside digital literacy, physical and mental health, and social and emotional skills, and is recognised as "essential for thriving in the 21st century" (**helloworld.cc/oecdlearning**).

Unlike the data education initiatives we are aware of in other countries, which tend to focus on teaching data science skills at the senior-secondary stage, the Data Education in Schools project aims to integrate data — and increasingly, AI — literacy across the entire curriculum for young people aged 3–18. Our goal is not just to upskill interested secondary-level learners who may then be inspired to pursue a career in data science, but rather to instil core data and AI literacy skills in all learners, whatever their future career paths, so that they can become informed



RESOURCES

If you would like to learn more about data and AI literacy or make use of some of our resources, here are some good places to start. All of the resources can be found at **dataschools.education/data-education-resources**.

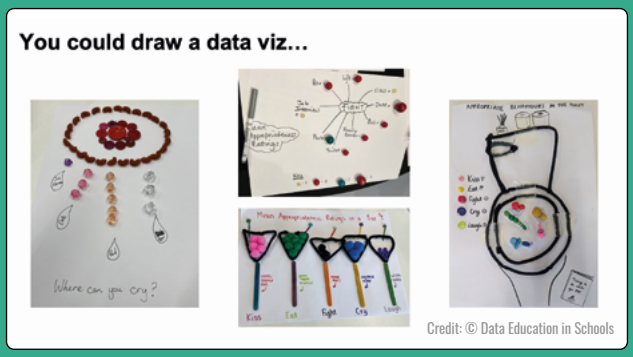
Early-years, primary, and early-secondary stages

- 'Teach Data Literacy: a guide for primary teachers' (**dataed.in/teachdata**) is a handbook developed to support teachers to enhance opportunities for all learners to build the skills and habits of mind relevant to data problem-solving. The guide offers practical guidance, links to resources, and a poster to support teaching data literacy skills and concepts across the primary and BGE curriculum.
- Data Explorer cards (**dataed.in/explorer**) introduce children and young people to a data problem-solving approach (PPDAC — Problem–Plan–Data–Analysis–Conclusion). The design builds on informal question-asking behaviours and supports learners' exploration of data in relation to the themes of Lego, Birds, Lost Property, Plastics, or a theme of their choosing.

Interpreting and creating data visualisations

- Weaving Data (**dataschools.education/resource/weaving-data**) is an award-winning unplugged activity in which learners use strips of material woven into a fence or other large frame to display data, creating a collaborative art installation that is both eye-catching and conversation-sparking.
- Dear Data (**dataschools.education/resource/dear-data-6-lessons**) is a set of six STEAM lessons which teaches learners to gather and use data about themselves and their interests through different drawing and visualisation techniques, bringing together art and information in a gentle and beautiful way.
- Fizzy Data (**dataschools.education/resource/fizzy-data**) is an activity in which learners create a fun, physical representation of a provided data set using the materials and tools available.
- Data Viz Quiz (**dataschools.education/resource/data-viz-quiz**) introduces learners to ten different types of charts and graphs. The challenge is a ten-question quiz that can only be answered by understanding the information visualised in them.

■ Data Explorer cards introduce children and young people to a data problem-solving approach



■ Fizzy Data is zero-waste data physicalisation — representing data with objects that can be easily disassembled and used again and again

Learning through gamification

- Become a trainee secret agent and solve our data-themed escape room puzzles (**dataschools.education/escape**). Trainee agents will have to use graphs, charts, maps, and logic to uncover the plots and crack the secret codes. Along the way they are introduced to the basics of internet infrastructure, data centres, cybersecurity, and other digital and data skills topics.
- Solve problems and explore ethical conundrums using data by playing our interactive live lessons (**cyberskillslive.com/data**), which have now been played by over 40,000 learners across the world.

Learning with tech

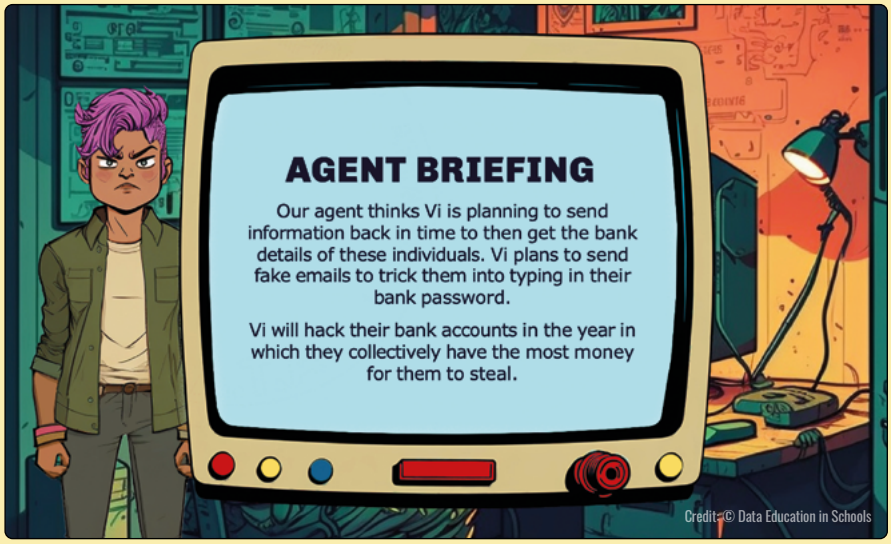
With Micro:bit Data Monsters (**dataed.in/monsters**), use your classroom micro:bits to create data-gathering monsters who will help you investigate temperature around your school. Check out the BBC micro:bit playground survey (**helloworld.cc/microbitsurveys**) for more data-themed activities using the micro:bit, with the bonus of incorporating outdoor learning.

Senior-secondary phase: the NPA Data Science

In 2018 we worked with the Scottish Qualification Authority (SQA) to develop qualifications in data science aimed at school and college learners. These awards are National Progression Awards (NPAs) which are aimed at assessing a defined set of skills and knowledge in specialist vocational areas and can be offered by either schools or further education colleges. The NPA Data Science is designed to be taught by teachers across a range of different school subjects, from maths or computer science, to earth, life, physical, and social sciences. Learn more at **teachdata.science**. Ready-to-use lessons using either Excel or Python are available at **learn-data.science**.

AI literacy

We have a web page (**dataschools.education/ai-literacy**) and Trello board (**dataed.in/ailinks**) where we pull together curated resources for teaching AI literacy from across the web, as well as some we have created ourselves. These are constantly updated as more resources become available.



Learners will become trainee agents as they solve puzzles using graphs, charts, maps, and logic to defeat the evil time-travelling villains

and empowered citizens able to navigate a rapidly changing, data-rich world. To echo the United Nations Convention on the Rights of the Child, young people must not be mere passive observers — they need to be able to participate meaningfully in societal discussions about the impacts, ethics, and design of new technologies, including ChatGPT and other emerging data-driven AI technologies.

> YOUNG PEOPLE MUST NOT BE MERE PASSIVE OBSERVERS, BUT MUST BE ABLE TO PARTICIPATE MEANINGFULLY IN DISCUSSIONS

Teaching data literacy

But what is data literacy, and how can we teach it? A definition we like to use is that 'data literacy is the ability to ask questions, collect, analyse, interpret, and communicate stories about data'. Using the PPDAC data problem-solving framework (Problem–Plan–Data–Analysis–Conclusion), learners can identify and investigate real-world problems that are meaningful to them. At the early years and primary stages, we focus on unplugged activities, gradually introducing more tech as learners progress to the secondary stage. Throughout, however, the focus is on conceptual understanding and critical thinking, rather than teaching the use of any particular tech tools.

We understand how overloaded the curriculum is, and how great the teacher workload. It is important to note that data literacy is already in the Scottish school curriculum, though scattered loosely across a range of different subject areas. The aim of our project is not to add yet more to the endless to-do pile, but to inspire teachers and learners with a fresh pedagogical approach to the curriculum through the lens of data literacy, which by its nature leads to interdisciplinary and curiosity-led learning.

In addition to developing classroom activities that teachers can use out of the box, our key mode of delivering data literacy is through teacher professional learning (**helloworld.cc/DataEducationLearning**). We run in-depth courses over multiple days, with a mix of in-person, hybrid, and online delivery to widen access, supporting teachers to co-create new pedagogical approaches and share them with their peers, not just during the course, but throughout their subsequent careers. We cannot overstress the importance of providing teachers with adequately funded, protected time for this type of professional development, which is critical if we want learning in schools to keep pace with societal and technological change.

From crocodiles to the classroom

Meanwhile, back in South East Scotland, the students at Addiewell Primary show a Scottish Television news crew the live data feed from their classroom sensors, side by side with the feed from the crocodile enclosure at Five Sisters Zoo. They explain the differences between the environments in the average levels of CO_2, temperature, and humidity. They point out a few spikes in the motion sensor graphs, explaining their theories about why the crocodiles move less frequently than the children. Their curiosity is still ablaze, and the question is, which animal enclosure will they investigate next? (HW)

JASMEEN KANWAL

Dr Jasmeen Kanwal is project officer on the Data Education in Schools team, focusing on curriculum development and professional learning. She has a background in data science by way of academic research across the fields of physics, cognitive science, linguistics, and biology, and is passionate about inclusive, interdisciplinary education.

(HW)

GOING TO CSTA'S ANNUAL CONFERENCE?

Hello World and the Raspberry Pi Foundation will be at CSTA's annual conference in Las Vegas and we'd love to meet you. Join one of our sessions!

- **Wednesday 17 July, 1–2 pm:** 'Empowering Students with AI Literacy: Integrating Artificial Intelligence into Computing Education' with Ben Garside and James Robinson
- **Thursday 18 July, 9–10 am:** 'Feedback for Wrong Answers in Online Assessment' with Diane Dowling
- **Thursday 18 July, 5:10–5:35 pm:** Flash Talk — 'Empowering Innovators: Code Clubs, Experience AI, and Ada Computer Science' with Diane Dowling, Ben Garside, and Kevin Johnson

Visit us at Booth 518 for free tote bags and more!

James Robinson
Senior Learning Manager (Curriculum)

Ben Garside
Senior Learning Manager (Experience AI)

Diane Dowling
Senior Learning Manager (Ada)

Hedy Brown
Community Engagement Coordinator

Kevin Johnson
Club Program Manager

Amanda Egbu
Club Program Coordinator

THE MULTIPLICATION OF ONE TEACHER'S IMPACT

Yolanda Payne gives insight into a teaching practice that can multiply the impact of one teacher across classroom settings

While many have declared that the Covid-19 pandemic is over, lingering effects have persisted and changed the way we conduct everyday life. No sector of our living experience was spared from those effects, and that includes school and education. The traditional classroom experience as we once knew it has been drastically modified. While many lament that as a loss, there have been developments from that time that may have long-lasting, positive impacts on student learning, teacher efficacy, and the field of computer science.

Computer science camp for K-12 students (ages 5–18) has been a staple of summers on the campus of Georgia Institute of Technology for more than a decade. As the campus — and the world — navigated the shutdowns in 2020, we were forced to cancel face-to-face computer science camps. As we grappled with that loss, we scrambled to provide some content, and made the decision to broadcast the camp content to individual homes. This was met with mixed success and didn't adequately mimic the classroom experience.

Lessons learnt from Covid

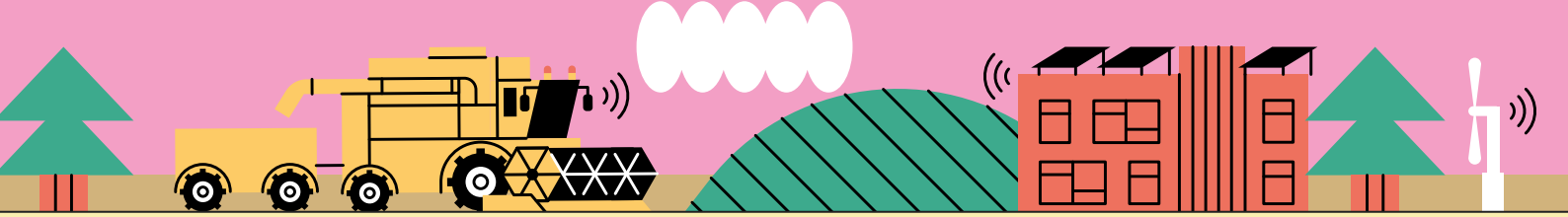
With life returning to some semblance of normality, requests for summer camp offerings were pouring into our office. Students and parents were longing for the computer science content that had been provided for years. When conferring with my former colleague, Nykema Lindsey, about possibilities to bring camp content to life, I came up with a model in which we would broadcast the CS teacher from their home or classroom, while having remote locations log into the content. Nykema was integral to the process as we worked to translate her efficient management and coordination of summer camps into a remote facilitated experience.

Instead of working in the isolation of their homes, students met in local facilities (schools, community centres, and churches) with on-site facilitators. While observing on-site distancing protocols, the face-to-face engagement with the technology tools and peers was critical to the success of students engaged in the camps. Camp facilitators learnt content with physical computing, 3D printing, Finch robots, and 2D and 3D design. Almost all of these concept areas were new to most of the adult facilitators engaged in the work, but because they got the opportunity to be active participants

YOLANDA PAYNE

Yolanda Payne is an avid Raspberry Pi fan. She has first-hand experience of working with students and adults to instil a love of physical computing. She is currently the inaugural Invention Education Fellow with the Society for Science and works as a half-time researcher at Georgia Tech in the US.

Students from various schools gathered at a local church in Albany, Georgia, to participate in camp activities; attending camp allowed them to access resources around 190 miles away



alongside the students, they quickly learnt the programs and were then able to deliver portions of the camps to students.
Each site had at least two or three adults working with groups that ranged from 10 to 20 students. This in-person teacher–student ratio was integral in the implementation of the summer camps. Each site then had access to an online instructor who was aided by an assistant instructor. This arrangement allowed one person to deliver content, while the assistant monitored the chat for questions and provided remote assistance to any students who might have had issues. With remote, socially distanced locations set up in a wide range of settings, we went about the business of teaching computer science content to students, educators, and facilitators.

How is this different from traditional virtual learning?

As we are now looking at ways to increase capacity — for educators and for students — I believe that this model provides a viable solution for increasing student access to quality computer science instruction and giving facilitators, who are often new to the field of computer science, an opportunity to learn alongside their students. This method of scaffolded teaching gives educators access to tested methods of instruction, modelled for them in daily interaction.
As they become more confident in their computer science skills, the remote facilitator is able to gradually release responsibility for lesson instruction to the in-class facilitator. With a connected monitoring system of computers, the remote instructor is able to oversee student activity, while also providing the instructor with additional assistance when needed.

With partnerships firmly in place, this model is now becoming the basis for reaching student audiences in local, remote, rural, and underserved areas of the state of Georgia and the US Virgin Islands. The key components of this model are the blending of face-to-face instruction, highly engaging online content, and established partnerships between the remote instructor and the in-class facilitators. As the remote instructor is able to be the subject matter expert, in-class facilitators manage the day-to-day routines and classroom management portions of the in-person classrooms. As we have piloted this model in other situations, we recognise that another integral portion of this arrangement is having intentional planning and reflection time so that adults can come up with strategies to enhance learning, share ideas, and manage any housekeeping activities that need to take place.

Logistics and engagement

As we were planning the execution of the camps, we developed a centralised supply list to ensure that we had materials for each camp. By the summer of 2022, we were running six- to eight-week camps in five or six locations, depending on the availability of staff and the donations of space we received. By standardising the list of materials needed to run camps, we were able to order in bulk and then distribute the resources across the different sites. Shipping of materials was a significant cost, and so as in-person meetings became the norm again, we asked facilitators who were travelling to the sites to take materials.

Generous grant funding from the Hopper-Dean Foundation and Infosys Foundation USA allowed us to fund the camp endeavours, teacher professional development, and equipment. Students, educators, and camp staff had access to materials such as Finch robots, Chibitronics, micro:bits, 3D printers, and Cricut machines. This funding also allowed us to pay staff a very decent wage, often allowing them to make enough money in short increments and still have time off to enjoy a summer break.

While the initial investment was costly, the benefits of having informally trained CS educators make this a worthwhile investment. By introducing educators to computer science in a friendly format, showing them ways to integrate computer science across content areas, and engaging students in activities that capture their attention, creativity, and imagination, integration of computer science into daily school curricula becomes more likely. An added bonus is that students who attended summer camps are now equipped to help peers and adults in these areas during the school year.

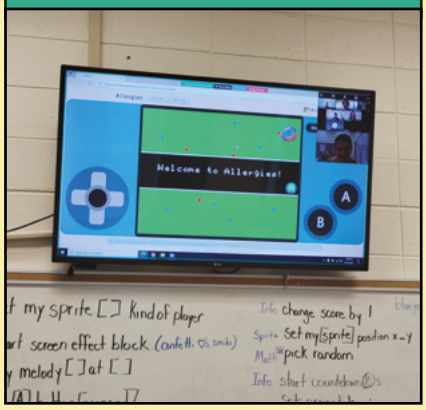
Continuation of the model

As we are working to secure funding for additional partner engagement, we still rely on this model to interact with our remote sites in Albany, Georgia; St. Thomas, United States Virgin Islands (USVI); St. Croix, USVI; and other rural parts of Georgia.

An integral part of the success of this model was based on the trust exhibited by the local communities that the institutions worked with would provide care and content that was beneficial to them. By using this hybrid model of engagement, we are able to add a human connection to remote learning that deepens relationships and gives participants a sense of connection across places and spaces. That added element also helps to eliminate barriers and fight isolation. (HW)

PHYSICAL COMPUTING CONNECTIONS

Students enjoyed a variety of activities related to physical computing activities, with an online instructor hundreds of miles away. MakeCode Arcade was a popular component of the game design courses. The MakeCode product by Microsoft provides students access to online environments when physical computing devices are not available.



BRIDGING THE DIGITAL SKILLS DIVIDE

Navigating the transition from consumer to creator in the Chromebook generation

A paradox has emerged in the swiftly evolving landscape of educational technology: the innovations designed to streamline access to information and simplify user interaction are inadvertently eroding fundamental digital literacy skills.

The Chromebook generation

As a secondary-school computing teacher, I've observed first-hand the challenges faced by the students I call the Chromebook generation. This cohort, raised on a diet of Chromebooks and iPads in primary education, encounters a steep learning curve when transitioning to the more traditional desktop computing environments prevalent in secondary schools.

The shift from touchscreens to the world of USB mice and keyboards exposes a gap in basic digital competencies. Issues that were once non-existent have become prevalent after the Covid-19 lockdowns. Students grapple with concepts such as uploading and downloading files, a task that is fundamental in the digital era but obscured by the seamless interfaces of platforms like Google Classroom. The distinction between saving a file and choosing its destination, understanding file extensions, and organising documents into directories are alien concepts to many. The blurring of lines between files and software applications highlights a conceptual gap in understanding digital tools that leads to errors such as believing a document is saved in Word.

LEWIS PARFITT

Lewis is a computer science teacher and pedagogy lead. With industry experience in web development, he's passionate about enhancing ICT literacy for teachers and learners (**@lrparfitt**).

Passive consumers

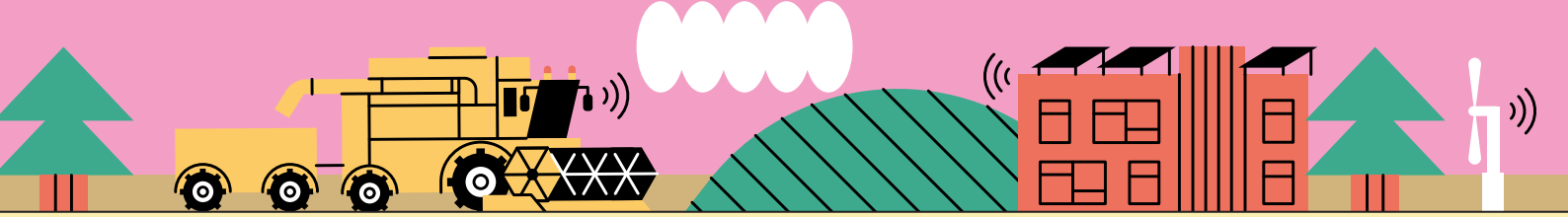
Moreover, a reliance on touch interfaces has left some students unfamiliar with the use of a mouse, and the term 'desktop computer' is often mistakenly used interchangeably with 'laptop'. Additionally, there is a misconception that 'data' refers solely to one's mobile Wi-Fi allowance, underscoring a broad misunderstanding of digital terminology.

The skills gap is not uniform, as students with access to traditional computers at home may not face these challenges. However, the disparity in digital literacy is more pronounced than ever, signalling a shift in the skill sets being developed. This scenario underscores a critical issue: while technology aimed at democratising access to digital resources is invaluable, it also risks fostering a generation who are passive consumers rather than creators of digital content.

Bridges to computer systems

The role of educational technology like the Raspberry Pi becomes ever more critical in this context. With its affordability and ability to function as a comprehensive computing platform, the Raspberry Pi 5 is a potent tool for reintroducing students to the foundational aspects of computing. It serves as a bridge, offering hands-on experience with the core principles of computer systems at an accessible entry point.

Addressing this digital literacy gap requires a concerted effort from both primary and secondary education sectors. The first six weeks of Year 7 (11- to 12-year-old students) in our school have been adapted to incorporate basic digital skills training, laying the groundwork for a



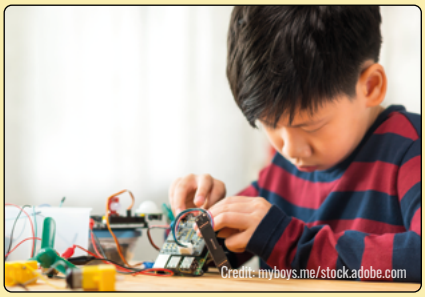
more informed and capable student body. However, this is only a starting point.

The integration of technology in education must be approached with discernment. There is growing evidence to suggest that the indiscriminate use of digital tools can impede learning progression. Technology should enhance education, not serve as a crutch or be used for its own sake. This principle is crucial in ensuring that digital resources are employed

> TECHNOLOGY SHOULD ENHANCE EDUCATION, NOT SERVE AS A CRUTCH

effectively, enhancing learning outcomes without compromising the development of essential skills.

In conclusion, the impact of technology in education is profound, with the potential to both empower and inhibit. As educators, our challenge is to navigate this dichotomy, ensuring that while we embrace the ease and accessibility technology offers, we do not lose sight of the critical skills that underpin digital literacy. By fostering an environment that values creation as much as it does consumption, we can prepare the Chromebook generation to navigate the digital world with confidence and competence. (HW)



Educational technology reintroduces foundational aspects of computing

Chromebooks and iPads have helped democratise digital technology, but risk fostering a generation of passive consumers

RECOMMENDATIONS FOR EDUCATORS

For primary-school teachers:

1. **Integrate basic computing skills:** embed lessons that introduce basic computing concepts, including file management, typing skills, and understanding the hardware components of a computer. This foundation will prepare students for a smoother transition to more complex computing environments.
2. **Promote balanced tech exposure:** ensure students have exposure to a variety of technology platforms, including desktop computers, to foster adaptability and familiarity with different interfaces.

For secondary-school teachers:

1. **Assess and address skill gaps:** an early assessment of incoming students' digital literacy can help tailor the curriculum to address specific deficiencies. Incorporating basic digital skills lessons into the early weeks of secondary education can mitigate the impact of these gaps.
2. **Foster digital creation:** encourage projects that require students to become creators using digital tools, such as coding with Raspberry Pi, digital art, or multimedia presentations. These activities not only improve technical skills, but also enhance creative thinking and problem-solving abilities.
3. **Collaborate with feeder schools:** establish a dialogue with primary feeder schools to understand the digital education landscape students are coming from. Collaboration can lead to a more cohesive approach to developing digital literacy across the educational spectrum.

THE WORKSHOP OF DIGITAL WORLDS: UNLEASHING CREATIVITY THROUGH AI

Mario Catalano looks at computational thinking, AI, and creativity in primary education

Imagine a learning environment where kids don't just learn — they grow through hands-on exploration. Inspired by historical craft workshops, the Workshop of Digital Worlds project immerses students in an apprenticeship-style experience. Here, school subjects transform into tools for tackling thought-provoking questions and problems, fostering cognitive development and unlocking the creative possibilities of technology. As mathematician Seymour Papert believed, children learn best by actively exploring and manipulating concepts. He called these immersive learning contexts "microworlds and incubators of knowledge" (helloworld.cc/papert).

MARIO CATALANO

Mario (PhD at University of Palermo, Italy) is a researcher, scientific editor, teacher, and digital animator with skills in machine learning. He deals with computational thinking and creativity, as well as artificial intelligence in basic education. Mario was honoured with the 2024 Italian Teacher Award (**linkedin.com/in/mario-catalano-31477869**).

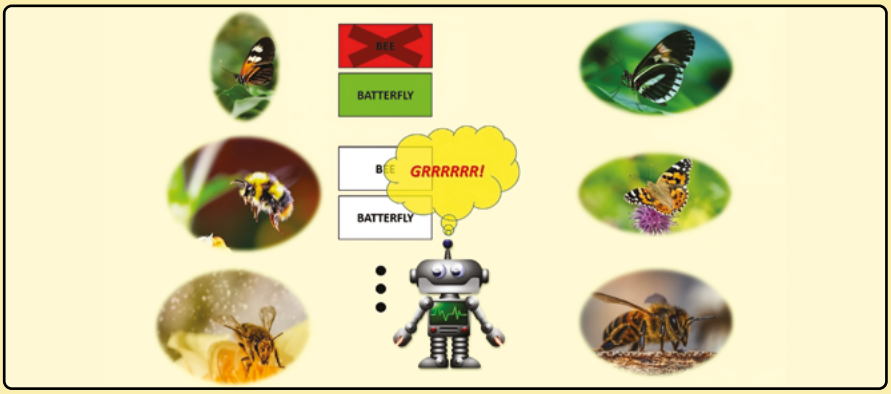
From wonder to code and AI

For almost two years, I have been engaging pupils in the final three years of primary school (around 400 schoolchildren) in computational thinking and creativity training through media design and educational robotics: the creation of animated stories and games with visual programming languages; the design and refinement of robotic skills; and the development of artificial intelligence algorithms to incorporate into video games and applications (fifth grade only).

At the heart of this learning journey lies the power of play, brought to life through exciting robotics challenges and hackathons. In this environment, the teacher is an animator, a coach, and an adventure companion who daily brings to the classroom their bag of wonder with new and intriguing secrets.

Exploring ethics and bias in machine learning

I would like to share the story of a learning unit that I used in fifth-grade classes, which I could call 'Building a Bridge between Artificial Intelligence and Bullying'. The unit aims to help students understand the logic of machine learning and reflect on the phenomenon of bias and the risk of transforming algorithms into amplifiers of prejudice. However, in line with digital citizenship education, the fundamental goal is to allow children to experiment with the technology's power in the service of the common good, with a focus on issues relevant to young people, such as bullying and cyberbullying.



A fun animation created by the teacher to explain machine learning

The anti-bullying cartoon — the viewer types the bully's response

The anti-bullying cartoon — the bully transforms into a terrifying T-Rex

In the first phase, guided in the use of a simple web application for non-experts (**basic.learningml.org/editor**), students develop a machine learning model to distinguish offensive text (bullying insults and derogatory expressions) from appreciation. They collect and provide the software with examples for each category (compliment, offence, or other), based on a study of the phenomenon that also involves other teachers of the pedagogical team.

Next, they perform automatic training of the text classification model and evaluate its accuracy and confidence level with test sentences not included in the initial examples. At this point, with the teacher's support, they realise that the performance worsens if the training examples are not diversified; they also consider how a sentence can be converted into numerical data for an algorithm, (for example, by counting the different types of words in the text).

The relationship between data quality and model behaviour provides an opportunity to discuss the ethical challenges machine learning is raising, from the dilemmas of autonomous driving to the use of 'intelligent' weapons or the risks of discrimination.

Kids become AI developers and anti-bullying champions

To complete the learning experience, pupils are invited to design and create a project choosing between two options: an app that recognises and filters hate speech online and generates cyberbullying alerts when needed; or a digital storytelling project that uses machine learning to raise awareness about the problem of bullying.

During the design phase, brainstorming sessions can be highly beneficial. These sessions should focus on key questions, such as who the ideal recipients for the alerts are (parents, teachers, or relevant associations); how we can effectively categorise the severity of aggressive messages (for example by using a tiered system); and whether the model should prioritise capturing all bullying instances, even if it means generating a higher number of false positive alerts.

To encourage innovation, the novice programmers tackle the challenge in collaborative groups, leveraging the teacher's insights. This engaging process mirrors a hackathon, where students explore the core elements and the social impact of contributing to innovation.

One project particularly impressed me. It's a captivating story that unfolds into a powerful anti-bullying video. A team of fifth-graders created it by integrating a machine learning model into Scratch, a visual programming environment. This model identifies offensive language used by bullies. The result is an interactive cartoon with a strong message. The story begins with two boys meeting after school. One greets the other kindly, but the second ponders his response. What happens next? The viewer can influence the narrative by typing in the response. If a degrading phrase is entered, the bully transforms into a monstrous T-Rex, symbolising the ugliness of bullying. A friendly fairy, representing the bully's conscience, intervenes with a powerful message: "Remember what you learned in school! Words can hurt! What if someone did that to you?"

The bully then chooses kindness, responding positively to the initial greeting. He turns back into a human, and the boys make plans for pizza. The story ends with a clear and impactful message: BULLYING IS NOT HUMAN!

This interactive cartoon is just one glimpse into a classroom exploring innovation. A number of thrilling further possibilities could be experienced to achieve these important outcomes:

- Learners, working both independently and collaboratively, discover their ability to create original projects
- Unleashing their creativity and critical thinking, they recognise technology as a powerful tool for self-expression and societal progress
- Through constructing algorithms, they gain insights into the logic of machine learning and its potential for ethical AI-driven change

The future is bright, and it's being shaped by these young minds. (HW)

The anti-bullying cartoon — the final screen

FUTURE-PROOFING STUDENTS WITH AI EDUCATION

Julie York shares strategies, current practices, and suggestions for incorporating AI education into classrooms to help prepare students for their future careers

Artificial intelligence is here, and it is everywhere. It's in our schools, in our pockets, and in our workplaces. When my students graduate, they will be entering a post-secondary world that requires an understanding not just of how to use computers and technology, but also how to interact with AI safely and effectively to improve their lives. In order for all my students to achieve this, I, as a teacher, need to prepare them with the necessary skills and understanding of what AI is, how it works, and how it can be used appropriately.

JULIE YORK

Julie teaches computer science and media electives at South Portland High School in South Portland, Maine. A CSTA Equity Fellow Alumni and an Amazon Future Engineer Teacher Ambassador, she is passionate about the opportunities CS can bring to all students (**@MrsYorkME**).

Modelling learning

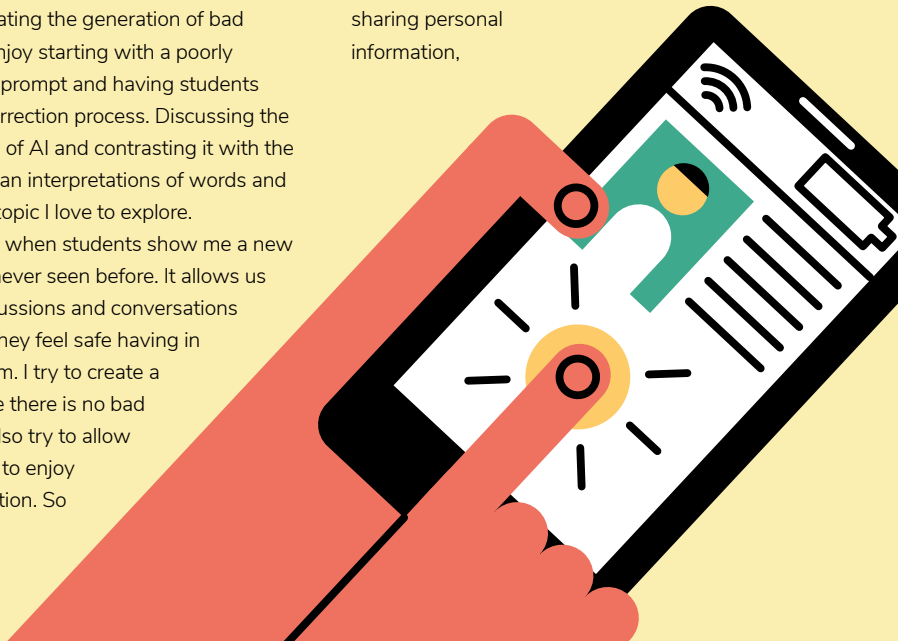
In my work teaching AI and using AI with my students, I have learnt it is important to understand that I am learning at the same time as they are. My classroom is the ultimate model of the teacher as learner and inquiry-based learning. For example, should a student in my room ask me for ideas for a project, one of my suggestions is to use Magic School's Raina and turn the question around to the student, asking them what kind of prompt we could use to get 50 ideas and then go from there. When students are designing a personal logo, I love to use Canva's image generator as a starting point, to give them ideas on what their designs could potentially look like.

Teaching students to interact with AI safely and succinctly is an essential skill for their futures, and there is value in demonstrating the generation of bad prompts. I enjoy starting with a poorly constructed prompt and having students guide the correction process. Discussing the literal nature of AI and contrasting it with the diverse human interpretations of words and images is a topic I love to explore.

I also love when students show me a new AI that I've never seen before. It allows us to have discussions and conversations that I hope they feel safe having in my classroom. I try to create a space where there is no bad question. I also try to allow for students to enjoy safe exploration. So if a student comes to me with a new AI, for example Suno.AI, which creates music from scratch, I like to talk to students as a whole, as well as that individual student, about how it could be used, whether or not it passes our safety checks, and whether it is appropriate to use in the context of our class.

Safety above novelty

As we move forward with using tools, we need to ensure they are being used safely and properly. This is why I ensure my students understand that it's fine to use AI in my class, but they need to discuss its use with me, and I need to be aware they are using it. That is the first step to safety. In my safety checks, I also investigate which information the tool collects. I aim to ensure that students aren't sharing personal information,



Julie York working with a student on a project in class that uses AI, design, and making skills

and that they understand any data they provide to the tool could be used and shared by it in the future. I want to make sure they don't rely too much on the tool, or use it as a substitute for learning. It's important that they understand the purpose of using the tool beyond entertainment; it must serve a role in the content. Is their use of AI being driven by the goals of their assignment?

I talk to them about bias, and encourage them to consider how information is collected by the tool, and who is using it. I discuss their privacy and whether the tool safeguards it. I address the importance of empathy, ensuring that while they are using the tool, they consider the impact their results may have on others.

Best practices still apply

The strategies I've learnt for teaching about AI use and AI creation are the same ones I apply across almost all the subjects I teach. I focus on critical thinking, problem-solving, ethics, collaboration, and global awareness. I believe it is important to emphasise the difference between artificial intelligence and human intelligence. I spend a lot of time discussing professions that will not necessarily be replaced by computers, and showing workplaces that have integrated AI tools, reinforcing the idea that AI is a tool for human use, similar to a calculator, rather than a complete replacement for a human.

A good example of this is the use of artificial intelligence in creating narration. For instance, if students use ElevenLabs.io to create narration for a movie trailer, most can distinguish between the artificial voice and a real person's voice. A fun activity to engage students is an 'Identify the AI' or 'Notice the Mistakes' activity, where I might present two examples in class and ask which one was produced by a robot. Or I flip this and do it as 'Trick the Teacher'!

Share AI with the whole community

I ask questions, take suggestions, and frequently model appropriate citation and use. In my classroom, I require all students to sign an AI use agreement and send information home to guardians to ensure they are aware AI is being used in my classroom.

AI should be recognised as something that goes beyond being just an activity for technology classes. As a computer science and media teacher, I am passionate about using technology and investigating the purpose and ethics of technology, but it's crucial that the entire community gains a better understanding, which includes sharing information with everyone. AI usage needs to extend beyond the computer science classroom. One way I try to influence this is by sharing AI tools with teachers, and sharing with others some of the practices I use. I might demonstrate to teachers how I use Diffbot to break down an article, or I will share my permission slip with other departments interested in having students sign an agreement when they use AI.

I also listen to other teachers and observe what they are doing in their own spaces. I love learning how other teachers are using AI and which programs they are using, so I can gauge the current school climate. This helps me better understand what students are being exposed to and what other teachers consider to be best practice.

> AI IS A TOOL FOR HUMAN USE, SIMILAR TO A CALCULATOR, RATHER THAN A REPLACEMENT FOR A HUMAN

In conclusion, I believe AI can be an incredible tool to help us be more productive, creative, and efficient. There are many problems requiring extensive data processing that can be aided by the use of AI. As it is developed and incorporated into more careers and technologies, I think our students need to be prepared for a future that includes AI, just as the present does, and it is my job to do my best to prepare students for that future. (HW)

USING GAMIFICATION TO IMPROVE ENGAGEMENT IN CYBERSECURITY

Victoria Berkowitz shares ideas for how to get started using gamification in your lessons

Imagine you have a brand new class excited to learn about cybersecurity. You are excited to teach it. Then you all complete Unit 1 and are already dreading the next unit. Maybe you don't have to imagine this; maybe it is you. It was me, too. How could such a cool course turn sour? I heard feedback like the work was busy work, or got questions like, 'Why are we even doing this?' Sometimes, as teachers, we are handed beautifully packaged curricula that are just that: beautifully packaged and not so great inside. I was determined to change that, and began my journey of gamification.

VICTORIA BERKOWITZ
Victoria is a software developer turned computer science teacher. She works at Mineola High School in the USA, where she teaches GameMaker, robotics, AP CS principles, and cybersecurity. She loves all things teaching, whether it be in public schools, volunteering, or children's ministry (**@v_berkowitz**).

Gamification versus game-based learning

I want to clarify the difference between gamification and game-based learning. Game-based learning is when you use existing games to achieve specific learning outcomes. Gamification is using game-like elements in your lesson to make it more engaging.

In my class, I started out using gamification by adding small things to my lessons such as a countdown timer to add a sense of urgency; little challenges in activities; turning typical activities into competitions; and letting learners work in teams. I created small stickers related to each unit and turned them into mastery badges they could earn to put on their iPads.

Real roles

I then came across an interesting study. This study compared science students' performances using just a lab coat (**helloworld.cc/labcoats**). Kids with low self-efficacy in their science skills had a significant improvement in their beliefs in abilities, levels of recognition, and science career aspirations when wearing a lab coat compared to kids who did not. The lab coat simulated the feel of being a real scientist! I wanted my learners to feel like real professionals in the field, so I gave them roles for activities that modelled a career in industry.

Suddenly my learners were no longer students in a building, but Department of Homeland Security special agents investigating a nationwide blackout; a student trying to hack their teacher's gradebook; a cybersecurity communication specialist ensuring our nation's security with public-service announcements; and a hacker paid to manipulate a database and pose a data breach. Not only did I assign them these real roles, but I also made the simulation more realistic by using props and scene setting.

When learners were special agents, I addressed them as such and dumped heavy briefing folders on their desks every day. I labelled the documents as 'Classified' in big red letters and paired them with a briefing


Homeland Security

January 16th, 2023

Re: 297924H1-909

Special Agent,

This is your briefing assignment for your team from the Department of Homeland Security.

On the morning of July 4, 2018, a nation-wide power and internet outage occurred. The outages begin on the east coast and affect the central and mountain time zones as routine business hours begin. The only open lines of communication at the beginning of the scenario are on the west coast, and it is up to DHS to discover the cause of the outages before the entire country goes dark. Because of the timing of the outages, the government immediately suspects foreign state actors, terrorist groups, hacktivists, or some combination of those three. Because of the nature of the outages, DHS suspects that they could have been caused by a cyber attack or by some sort of EMP device.

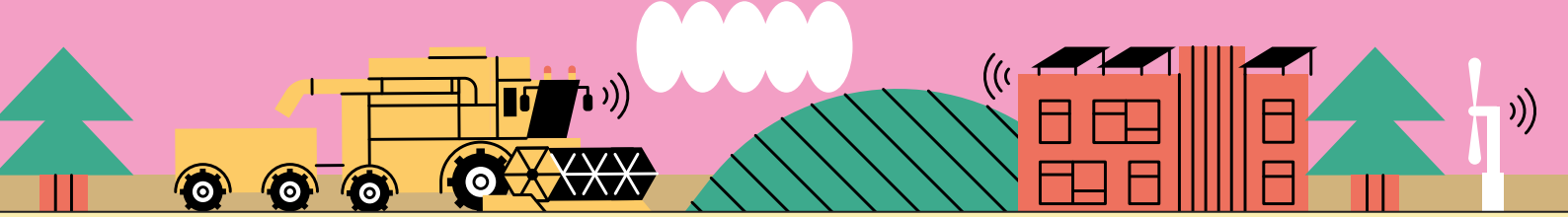
Enclosed you will find collected evidence and materials. Your assignment is to construct a cybersecurity report as a team. Make sure to develop a potential theory of what happened, who did it, why, and what should be done in response. We will discuss your findings as a team at our next department briefing.

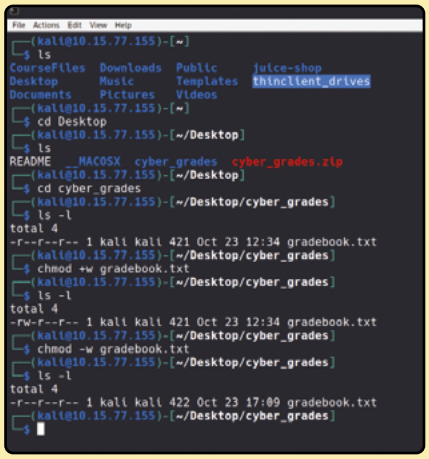
Sincerely,

Jen Easterly
Director of DHS

CONFIDENTIAL

Learners assigned special-agent roles had heavy briefing folders dumped on their desks every day





Some students were assigned hacker roles, in which they worked on getting access to their teacher's gradebook

Some learners were assigned the roles of paid hackers and had to manipulate a database

email from the director. When learners were hackers trying to get access to their teacher's gradebook, the file they needed to change permissions on included their real names and was personal to them. When learners were cybersecurity communication specialists, they had to make an actual public-service announcement after watching ones already made. I created a scenario in which learners were paid hackers that had to manipulate a database to make a potential political candidate look bad. In all these scenarios, I had them take a role or job that is real, and apply skills they would have learnt in a realistic manner. (Knowing the hacker role and point of view is fun, but it's also critical when holding a defensive job in cybersecurity.)

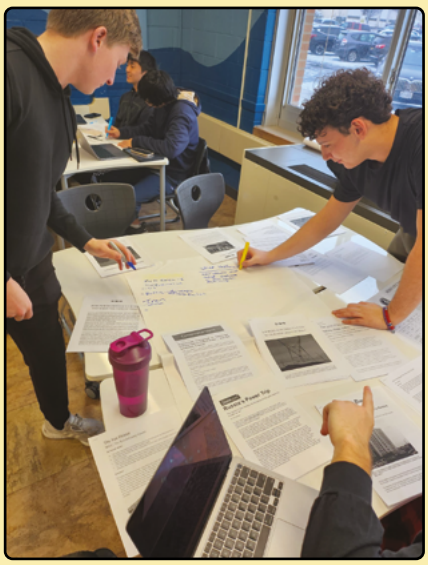
Meaningful work survey

I wanted to ensure I was doing something that really made an impact, so I surveyed my learners before and after implementing gamification, using a PERTS Elevate survey (**perts.net**). This survey is a free online tool that measures the academic mindsets of learners and their perception of different values in school, ranging from student voice and affirming identities all the way to learning goals. After implementing gamification with a real focus on simulation, my learners' academic mindsets pertaining to meaningful work improved overall by 14 percent, meaning 14 percent more learners found the work more meaningful. The survey rated them on whether they felt the work was meaningful, connected to the real world, and really interesting.

Gamify your lessons

Gamifying your lessons does not have to be hard. It does not have to be a revamp of lessons. It can be as small as using an online countdown timer to add a sense of urgency to everyday activities like do-nows in your class. It can look like turning a project into a competition where the best project wins. It can even be as simple as grouping learners and putting them on 'Teams' with a theme.

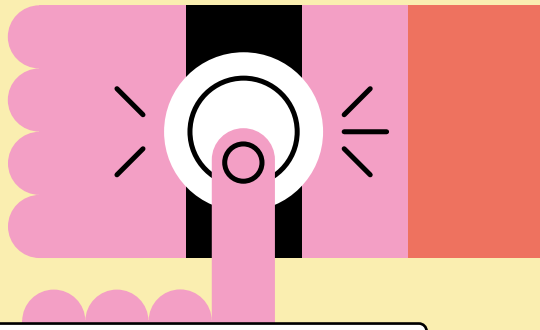
Have extra stickers or swag lying around? Make a prize box and use it as the loot box! Give your kids specific roles that relate to what they are doing, and call them that all day (calling each of my high-schoolers 'special agent' made them feel so cool, and they played along too). Even putting little challenges that relate to the content in your typical activities motivates learners to push themselves.



Learners assigned to be cybersecurity communication specialists had to create a public-service announcement

Changes in my classroom

Beyond the survey results, I also noticed big changes in my classroom. I saw increased motivation and efficiency. I noticed more collaboration and helpfulness, or a sense of community. I noticed increased ownership of work, and learners having fun. Lastly, I noticed that I almost never get questions such as 'Why are we learning/doing this?' any more. (HW)



LEARNING CONDITION	RESPONSES	RATED POSITIVELY ON LAST SURVEY	± FROM FIRST SURVEY
Meaningful Work 23 (of 23) responses	All (23)	75%	+14
In this class, we do meaningful work, not busy work. 23 (of 23) responses	All (23)	57%	+14
What we learn in this class is connected to real-life. 23 (of 23) responses	All (23)	96%	+18
This teacher makes what we're learning really interesting. 23 (of 23) responses	All (23)	74%	+13

A PERTS Evaluate survey can help measure the academic mindset of learners

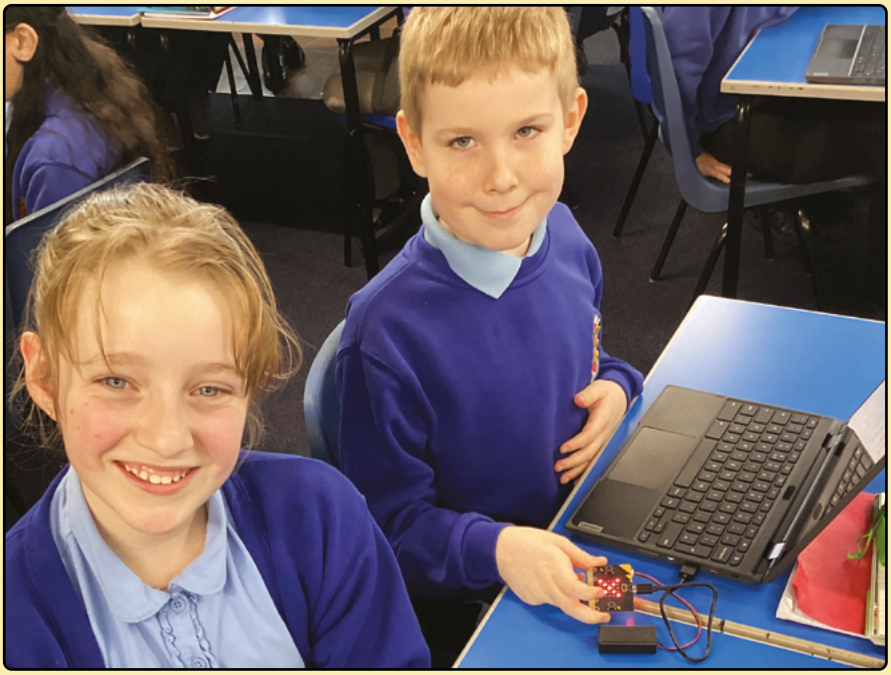
CODING FOR CLIMATE ACTION

Matt Hewlett highlights a new engaging scheme of work that introduces physical computing as a way to mitigate the climate crisis

Kenya is currently coming to the end of its long rainy season which runs from March to May, and for large parts of the region, this is a much-needed relief from a multi-year drought. But for many others, this is a devastating time. Heavier than usual rainfalls have resulted in flooding and disruption, which in turn have resulted in an estimated 267 deaths, 188 injuries, and the displacement of 281,835 people, not to mention the onward impact on vital services and sanitation and hygiene facilities. While it's hard to see this as anything other than harrowing, it could in fact have been even worse. However, early warning systems (EWS) have been used to predict and, where possible, mitigate the worst impacts of the rains.

The Famine Early Warning Systems Network has taken "data from a variety of ground- and satellite-based observational networks" and provides daily updates and 15-day forecasts that can be used to save lives (**helloworld.cc/kenyawarnings**).

These floods are in part a consequence of climate change. As the reality of climate change is less and less contested, and its impact more and more evident, it's incumbent on anyone and everyone to think about how they can best be part of the solution. As educators, our most valuable tool is our ability to engage, inform, and excite young people with a view to equipping them to meet the challenges of the future. It's with this in mind that we (Digit<all>) and Amazon Future Engineer developed the free Coding for Climate Action scheme of work that highlights a range of early warning systems while also introducing students to the micro:bit.



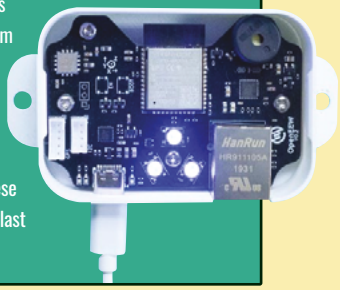
Students from Weddington Primary School in Nuneaton, England, send earthquake warnings using the micro:bit's radio feature

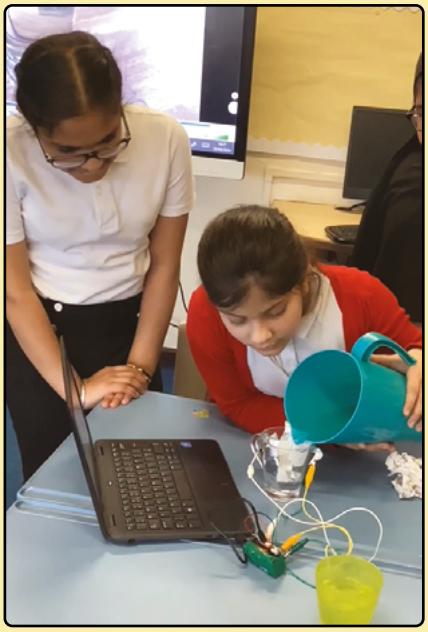
The power of physical computing

We all know that the best way to teach young people is to bring a topic to life. In the world of computing education, micro:bits are second to none in this regard, so it's no surprise that they lend themselves brilliantly to this scheme of work. The Coding for Climate Action scheme of work introduces students to the context of climate change before demonstrating different EWS that are used to mitigate them, such as the Bosch fire detector, which detects fires and sends alert signals. Lesson by lesson, students explore different features of the micro:bit and how it can be used to make a prototype of an EWS. For example, students will use the light and temperature sensors on the micro:bit to send

EARLY WARNING SYSTEMS

Early warning systems (EWS) such as the Grillo (pictured) are used to mitigate the impact of disasters such as floods, wildfires, and earthquakes. Using technology to provide advanced warning of these events has allowed deaths from climate-related disasters to be reduced, despite the increase in occurrences of these disasters over the last 50 years.





Students from James Watt Primary School in Birmingham, England, test their flood early-warning system

an appropriate warning, and discuss when and how this warning would be appropriate. The micro:bit pins are used to make a flood detection system, and the motion sensor and radio function are used to create a network of earthquake warning systems (OK, this isn't climate related, but it's still a vital example of an EWS!).

Seeing these concepts made real via physical computing has allowed students not only to study the theoretical concepts, but also to actively engage in making them a reality. If you've used micro:bits before, you'll already know the sort of magic they can bring to the classroom.

Meeting the curriculum

There are two schemes of work available, both of which are free to access. One is aligned with the English KS2 curriculum (ages 7–11) and the other with KS3 (ages 11–14). Teacher confidence was also a key consideration when developing the resources, and as such they are detailed and comprehensive. Furthermore, explanatory videos for each lesson are available on the Digit<all> website to help cover any technical or coding aspects that might otherwise inhibit a teacher wanting to commit to the scheme of work.

We are also aware of student confidence and cognitive overload when attempting creative coding tasks, and so all tasks start with prewritten code that students get to explore and extend. There is something for everyone to enjoy regardless of coding experience and ability. To aid monitoring and assessment there is also a work journal for students to complete lesson by lesson.

On the frontline

The resource has been running in schools in England and Wales over this academic year. We've been lucky enough to get some great feedback from teachers and students who have loved having a unit of work with a powerful and meaningful context, not to mention something to use UK primary schools' free micro:bits with!

There have in fact been some wonderful individual reports of engagement and impact. For example, in one school, the exploration of the pins function for the flood detection system resulted in an electrical circuit being created from a micro:bit, a glass of water, 30 students, and a teacher! In another school, a student who was refusing school enjoyed the unit to the extent that it was used to phase their return to school, which has now, happily, become permanent. It must be said, though, that a unit of work can only do so much; high quality and compassionate teaching will always be central to transformative education.

As I'm writing this in the UK, I'm reminded that we're lucky not to experience events like those in Kenya — yet we all experience the local effects of climate change in one way or another. Young people are particularly engaged with this topic, and rightly so. As such, we hope that this unit of work will be a way of showing how we can begin to tackle these vital issues at local and global levels, as well as starting a conversation about the importance of preventing as well as mitigating climate change. If you're interested in using the resources, please do check them out on our website: **digitall.charity/codingforclimateaction.** (HW)

DIGIT<ALL>

Digit<all> is a charity that offers free computing and digital resources, continuing professional development (CPD), and workshops for schools in the UK. They are passionate about delivering engaging and context-orientated computing that helps make the subject as accessible and impactful as possible for teachers delivering it. You can see the free resources on their website: **digitall.charity**.

AMAZON FUTURE ENGINEER

Amazon Future Engineer is focused on helping prepare young people for a digital future. Working with partners like Digit<all>, it has helped reach over half a million young people in the UK through a variety of projects and initiatives. You can find their resources and projects, including Coding for Climate Action, on their website: **amazonfutureengineer.co.uk**.

MATT HEWLETT

Matt Hewlett is the community and education lead for Digit<all>, as well as being a teacher trainer, resource writer, micro:bit Champion, and Raspberry Pi tinkerer.

IS TECH DIVISIVE OR INCLUSIVE?

Ben Hall discusses equity, diversity, and inclusion and the impact of tech

Technology is divisive. Some people have access to it and some people don't. While many people take technology for granted, others are completely excluded. It's not just what devices you own or can access, but also the infrastructure around you. If you live in a community which is technologically isolated, how can you get the same opportunities as someone who benefits from almost limitless access? Even in the UK, the sixth-largest global economy, 45 percent of people are classed as being 'digitally excluded' (helloworld.cc/gdp-by-country, helloworld.cc/uk-digital-exclusion).

BEN HALL
Ben is a learning manager at the Raspberry Pi Foundation, where he develops training resources to support computing educators worldwide (**@hengehall**).

Not only is technology divisive, but it can also exhibit toxic and controlling behaviour, and that's the worst kind of relationship. Social media platforms decide what content is delivered to you based on an algorithm you can never see, let alone understand. As the algorithm learns what you prefer to interact with, it feeds you more and more similar content, creating an echo chamber effect. No longer are you seeing a balanced and nuanced view of the world around you, but instead an increasingly narrow and blinkered outlook. What's more, you don't even know if what you're reading is true, or even if it has been generated by humans.

Misuse of technology is widespread, and you don't have to look far to find abuse and hate on the internet. Given this bleak reality, how can we expect technology to be a force for promoting equity, diversity, and inclusion? Well, read on, because all is not lost.

Access for everyone

Access to technology is improving. A major milestone was reported by GSMA in 2023 (**helloworld.cc/global-smartphone-ownership**). They found that 4.3 billion people worldwide now own a smartphone — that's over half the people on the planet. Statista predict that by 2029, that number will be nearly 6.4 billion (**helloworld.cc/global-smartphone-users**). These numbers are astonishing, particularly when you consider that the first phone with internet connectivity was introduced in 2001, and the first iPhone did not appear until 2007. The smartphone revolution has been rapid, and is ongoing. In addition, 97 percent of the global population lives in an area served by mobile cellular networks (Statista) and by 2028 it is forecast that 88 percent will be served by 5G mobile coverage (**helloworld.cc/global-5g-coverage**). If access is improving, then is everyone reaping the benefits?

Disadvantaged communities

There are numerous examples of people from disadvantaged communities overcoming barriers to the use of technology to improve their, and other people's, lives. For a recent project, the Raspberry Pi Foundation developed a computing course to improve digital skills amongst a refugee community in Northern Kenya. Students learnt vocational skills such as desktop publishing and website design, which they then utilised to develop content for the benefit of their community. The project involved providing shared laptops and tablets so that the students could access technology during the classroom-based sessions. Other content was adapted to be accessible away from network coverage, ensuring that students could continue to learn away from the classroom. For the final project, students arranged themselves into groups, utilising a variety of technical and creative skills. The learning was facilitated by locally based trainers, and once the barrier of access to technology was removed, the students progressed at a remarkable rate.

Elsewhere, technology is providing solutions to communities which have been underserved by modern systems. One example is banking. In South East Asia, 70

Over half the people on the planet own a smartphone

percent of people are 'underbanked', meaning they do not have access to basic financial services such as a bank account or the opportunity to borrow money (**helloworld.cc/tech-se-asia**). This is a two-way problem: financial institutions have been reluctant to lend to those without credit history, and in some communities there is a lack of trust in the banking sector. This makes it difficult for huge numbers of people to save money or invest in their homes or businesses, seriously restricting their economic potential. You may think that technology is one of the causes of this exclusion, but in this case it can also be the solution. There is a growing trend in the financial sector for providers to offer micro financial products such as small loans, insurance, and investment products to people without credit histories. Instead, they look at daily transaction records or data usage to assess suitability for these products. Young people in urban areas are driving this change by demanding such products and services. Access to data and apps developed specifically to increase financial inclusion are helping to enable this change.

> "WHEN IT COMES TO EQUITY, DIVERSITY, AND INCLUSION, TECHNOLOGY CAN BE BOTH THE PROBLEM AND THE SOLUTION

As you can see, the relationship between technology and equity, diversity, and inclusion is not always a simple one; technology can be both the problem and the solution.

Critical thinking

The key is access, to both the technology itself and the education to use it positively and productively. As an educator, one of the most important skills you can teach young people is to be a critical thinker. Those with access to technology need to be encouraged to think critically about their use and interaction with it, and about how they can make technology an enabler in their lives. The motivation of young people does not necessarily have to be altruistic or spring from a desire for equity; it could be that they see technology as a route into a particular career, or a means of financial gain. The important thing is that they can recognise the potential that is offered by technology. Critical thinking can also help young people to assess their own relationship with technology and see the potential in being a technological creator. Being creative with technology can be done in broad ways, from writing code to solve problems, to creating digital media to communicate messages.

Returning to the question posed in this article — is technology divisive or inclusive? — in my view, it's both. But as educators, we have the opportunity and privilege to be able to provide young people with the skills to challenge it when it is divisive and promote it when it is inclusive. (HW)

CLASSROOM DISPLAYS TO SUPPORT E-RECYCLING

Louise Hayes shares ideas for connecting green computing to the classroom

The summer term in the UK is often a time for disrupted lessons and changes to the timetable. Students at Key Stage 4 (ages 14–16) are undergoing external examinations and the focus of classroom practice is preparation for their GCSEs or A levels. Lessons at Key Stage 3 (ages 11–14) can be equally disrupted, with examinations, school enrichment activities, and classrooms being changed to fit in with examinations around the school. This disrupted lesson time is an ideal opportunity for teachers to embed practical, and fun, unplugged-style activities, to "promote computer science (and computing in general) to young people as an interesting, engaging, and intellectually stimulating discipline" (csunplugged.org).

As a computing teacher and trainee educator, I encourage my students to bring in their electronic waste (e-waste) at this time of the year, when the focus is on a recycling project to create wall displays.

E-waste

Have a look around your home and count how many electronic devices you are no longer using which need to be recycled. Maybe you have a collection of cables that are no longer matched with their original device, or you might have an old internet router that your service provider didn't want back. Particularly in the UK, you aren't alone in this accretion of electronic waste. The UK is the second-highest generator of e-waste per capita in the world (**helloworld.cc/ewastestats**).

Students bring in their electronic waste for a recycling project

Learners in the UK are well versed in the recycling process for household cardboard, glass, and plastic, but where does household e-waste go? When broken and unwanted electronics go into landfill, toxic substances such as lead and mercury can leach into the soil and the water. Recycling e-waste helps to prevent this, and can also save the non-renewable resources used in electronics, such as gold, silver, and copper.

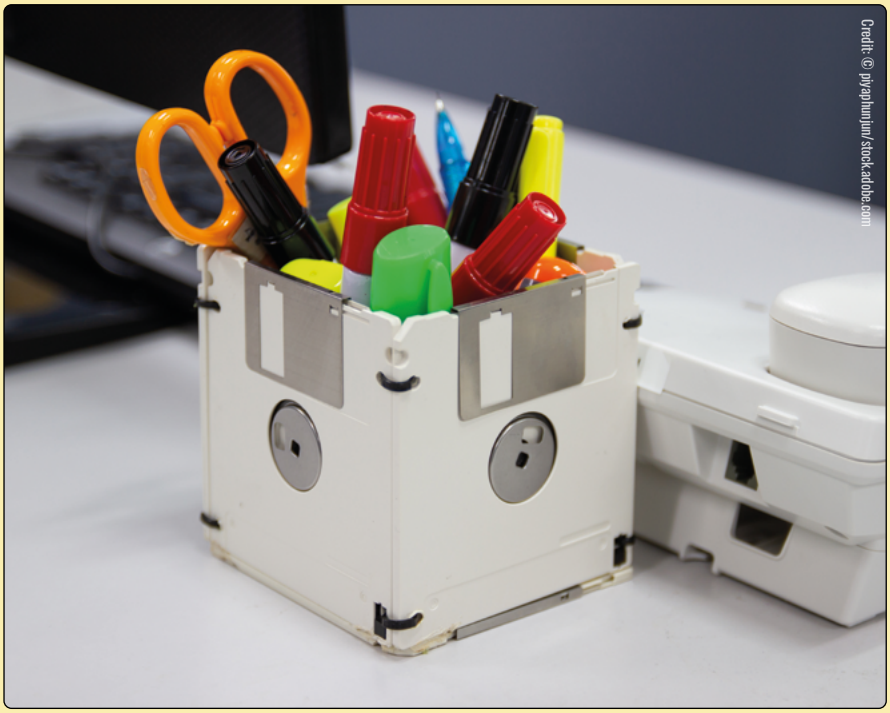
Green computing, or sustainable computing, is the environmentally responsible and eco-friendly use of computers and their resources. Although it's not part of the computing curriculum, it's a great subject for a cross-curricular unplugged activity about energy efficiency, upgrade culture, and recycling.

Classroom displays

Classroom displays are often last-minute creations due to time constraints; they are either quickly put together, or premade content is mandated by others to neaten up the space. While this makes the walls look tidier, I began to wonder if the displays were useful, inspiring, or encouraged recall. Were they memorable to the pupils in my classes? Did they influence the uptake of the subject?

As a trainee tutor, I remember being asked to consider how a cross-curricular recycling project, for example those from the World Wildlife Fund (**helloworld.cc/wwf**) or Recycle Now (**helloworld.cc/recycleweek**), encourages students to think about the impact of e-waste on the environment. This activity enabled the student teachers to work together on an enrichment project

A literal interpretation of green computing: a plant growing inside a CD player



Create a pencil holder using old disks, while explaining to your students what disks were!

as a homework or a whole-school activity. I recall working with an art teacher colleague (my artistic skills are limited!) on a project in which the pupils brought in a selection of floppy disks and wire coat hangers and these materials were used to create a hanging display in the classroom. This sparked interesting discussions for careers and open days. I now wish I had taken pictures of them!

Cross-curricular recycling display

Creating a recycled e-waste display is a way to reinforce learning, discuss physical components, and invite students to be creative. Students can make a display about e-waste. They can upcycle materials to create baskets, frames, and pencil holders. Learners can also research e-waste artists such as Antlre (**helloworld.cc/Antlre**) and HA Schult (**helloworld.cc/HASchult**).

Being mindful of school policy, which may dictate what is required, you may wish to include a careers section with subject-based pathways; consider how balanced the examples are, or set homework tasks for the pupils to create timelines or a history of computing that can be built into your lessons. CDs are a particularly useful discussion point for an abstract topic such as storage and file sizes. You may also want to consider how classroom walls can be included in computer science pedagogical practice. There are some great resources such as key words and definitions posters on Computing at School (**helloworld.cc/cas-resources**) that support a number of inclusive teaching practices and are hugely supportive of pupils' literacy.

Finally, this is the best time to take a fresh look around your classroom ahead of the start of a new academic year. (HW)

> GREEN COMPUTING IS A GREAT SUBJECT FOR A CROSS-CURRICULAR UNPLUGGED ACTIVITY ABOUT ENERGY EFFICIENCY AND RECYCLING

LOUISE HAYES

Louise Hayes has an academic background in business and computing education. She has worked in industry, starting out as a telephone operator on a Strowger telephone exchange, as a teacher, a teacher educator, and a lecturer, and has written about inclusive education in computing. She is currently teaching again and is enjoying being back in the classroom (**linkedin.com/in/hayeslouise**).

FUTURE-PROOFING CREATIVITY

Matthew Sisk shares his thoughts on navigating creativity in the digital age and what computer science educators can do to help shape the next generation of creatives

Within the constantly shifting digital terrain, computer science educators hold a pivotal position in preserving the future careers of upcoming creative minds. The impact of technology can be felt far and wide in almost every industry, reshaping and redefining our approaches to innovation and productivity. However, amid this wave of transformation, one industry stands at the forefront of change with a mixture of anticipation and trepidation: the creative field. From design and illustration to video production and copywriting, artists across these industries find themselves navigating a rapidly evolving landscape in which new technology both empowers and challenges age-old traditions.

MATTHEW SISK
Matthew is a film-maker at the Raspberry Pi Foundation, where he showcases the Foundation's work, tells community stories, and produces educational videos for students and educators on topics ranging from machine learning to physical computing.

Calling all creatives

Before AI became a buzzword in marketing departments, creative technologies were already harnessing the power of machine learning to give artists superhuman powers. From generating artwork to automating video editing tasks, AI has revolutionised the creative landscape, offering a glimpse into the future of digital content creation.

With these tools at our fingertips, solo creators and small teams can now rival industry Goliaths, levelling the playing field and turbocharging the slingshot. But with these evolving possibilities, it's not surprising professionals are worried about the future of their careers.

Despite the prevalence of AI-driven tools, creativity remains fundamentally human. Creativity is emotion, it's a vision, it's a journey from conceptualisation to realisation. It is not a one-click solution to artistic expression and originality. We need humans to give art of any medium purpose.

Looking back over 70 years ago, computer visionary John Diebold wrote that the impact of automation on business information handling could be even more dramatic and wide-ranging than its effects on workers (Diebold, 1952). Data entry clerks have evolved into GDPR analysts. We now have a whole cybersecurity industry. Similarly, there are more creative jobs right now than ever before, with the industry predicted to grow.

Creative teams may be less concentrated than they once were, but their talent is now dispersed throughout a business landscape that has the demand, resource, and recognition of the value that original thinkers bring.

As has been the case before, both low- and high-skilled occupations will feel the impact of increased computing capabilities. However, numerous existing roles will thrive, and new ones will emerge, fuelled by artistic craft (Press, 2023). While these disciplines are experiencing significant change, it's important to add that this change doesn't mean they're becoming obsolete. Just think about how AI can add value to what creative students can do.

Through my lens

In my journey with AI, I've discovered that my talent remains unchanged; I'm still capable of producing work at the same level of quality as before. However, with AI, the process from conception to completion has become significantly more efficient, requiring less time and resources.

Recent innovations in software have not only reduced the entry barrier in certain fields, but have also enabled the creation of more diverse and inclusive content from the outset. Additionally, by automating mundane tasks, these innovations free up valuable time, allowing me to focus on being a creative.

Setting aside the social, ethical, and political challenges AI presents, I find myself feeling more inspired and driven to make than ever before, exploring

the unimaginable possibilities that lie ahead with a new-found motivation and enthusiasm for the work that I do.

How to prepare

We need educators to equip students with the knowledge and skills to navigate the new world, ensuring they can wield this powerful tool with integrity, competency, and most of all, authority. My advice to impart to the next generation of creatives begins with the following:

- **Embrace lifelong learning:** every day my toolbox gets bigger, with more and more features that I don't know how to use and didn't even know I had. While AI can accelerate workflows and unlock new possibilities, it's essential to remember that creativity transcends technology. Students should be taught how to be good learners beyond the confines of the classroom. Teaching continuous development and advancing adaptability to ever-changing circumstances is an essential skill for navigating the unknowns brought about by technological advances.

- **Take advantage of being digitally native:** in today's digital age, being born digitally native is a significant advantage. Every day, younger talents armed with fresh ideas and digital literacy gained from their innate familiarity with the digital world are challenging industry veterans. Teachers can be open to learning from your students, also modelling the value of being a lifelong learner.

- **Go the long way round:** while AI offers new possibilities, true authority comes from competence beyond AI reliance. Ownership of skill and craft is built through knowledge and practice of all the techniques and principles that have come before. Artists of any discipline must know the road to proficiency to lead the way. With any of these tools, the outcome is only as good as the work you put in, and sorts the skilled from the unskilled.

New technology both empowers and challenges professionals in creative industries

- **Teach problem-solving:** the creative field calls for good problem-solvers. Every project, every brief, and every goal presents challenges that require solutions.

- **Collaborate with technology:** AI tools should act as a conversation between artists from concept to completion, a problem-solving partnership in which the creator always asserts control — not too dissimilar to the idea of paired programming. We need to teach how to construct ideas that function better in prompt-based environments. Tools need someone to wield them, and that squishy bit between your ears is more valuable than copper and silicone.

Future-proofing creativity

Computer science educators especially play a critical role in future-proofing the careers of the next generation of creatives. By instilling an innovative mindset, strengthening adaptability, and advancing interdisciplinary skill sets, educators can prepare students to thrive in a world where AI is unavoidably intertwined with creative processes.

FURTHER READING

Creative Industries Employment 14% above Pre-Pandemic Level (2023). Creative Industries Council. **(helloworld.cc/creative-employment)**

De Cremer, D., Bianzino, N.M., and Falk, B. (2023). *How generative AI could disrupt creative work.* Harvard Business Review. **(helloworld.cc/creativework)**

Diebold, J. (1952). *Automation: the Advent of the Automatic Factory* **(helloworld.cc/Diebold)**

Press, G. (2023). *Generative AI and the future of creative jobs.* Forbes. **(helloworld.cc/creative-jobs)**

True authority stems from not being reliant on these modern tools, and from the ability to override automated operations in favour of expression and self-belief. Any work involving the application of AI will always need to be checked by human eyes.

Futurist Roy Amara's law states that we often overestimate the immediate impact of new technologies and underestimate their long-term effects (**helloworld.cc/amara**). Currently, we're in a phase of speculation and prediction about what lies ahead. Creative minds play a crucial role in our future, unlocking new potential through imagination. Prepare for disruption. (HW)

(HW)

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ENGIDEA: VENEZUELA'S FIRST MAKERSPACE

Meg Wang interviews Laura Pantaléon, creator of Engidea, a makerspace where students can create projects based on technology

What are computer science education and digital making like in Venezuela?

In Venezuela, tech education is growing because the pandemic generated a need to connect us. Private schools, private universities, and some educational institutions created programmes based on computer science and ICT for their students, but the students of public schools and universities didn't receive any, or received poor education in those times.

As a consequence, today we have a tech learning gap between the students with access to computer science programmes or digital making applications and tools, and students who don't have access to these.

Engidea is a space for young people to learn how to use technology

What inspired your own interest in computer science?

Since my childhood, I invented machines taken from my imagination. My parents taught me to use the computer and I started to create my own designs. Through the years, I started to like industrial design, but at that time, the opportunity to study this career was expensive and my parents couldn't pay.

In 2008, when I graduated from my college, I saw a recommendation to study a new career in Venezuela at that time, as a mechatronics engineer. After five years I graduated and started to work at an automation company in Venezuela.

Why did you create Engidea?

In 2016, I had the opportunity to move to Spain and I worked in the robotics industry. I saw all the innovation available in the city of Madrid, and, for this reason, I dreamt of creating a company to design tech projects and teach Venezuelans to create their own. In this way, Engidea was born.

I like to show Venezuelan people how technology can help us to change our lives, and the best way to do this is learning how to use technology, by designing and making our own tech projects.

How have the students responded to the makerspace?

In Venezuela, the concept of a makerspace is not used. There exist spaces for co-working, tech centres and labs, 3D printing companies, and tech solution design, but we didn't have a space to integrate all of them.

Students can learn about robotics, 3D printing, and virtual reality

For this reason, in 2024, for our eighth anniversary, we officially registered as the first makerspace in Venezuela on Make:'s makerspace directory (**makerspace.com**).

Our purpose is to integrate our education programmes and space with events, machines, tools, memberships, and scholarships to allow kids, young people, and adults to create their ideas with technology.

Can you describe what a typical Engidea session looks like?

A typical session in our makerspace involves our membership programmes.

Our main programme is called Engilab, in which 6- to 14-year-olds can work on projects involving specialities such as robotics, 3D printing, video games, virtual reality, and home automation.

Our second programme is EngiTeach, for young people and adults aged 16 and up, in which they can acquire tech-based knowledge combined with educational methodologies based on STEAM education.

What do the kids do or learn about in an Engilab session?
Students choose the technology they want to begin to learn. For example, if your choice is robotics, you will make a robot design in 3D, add circuits, program the code, and print a prototype. Another choice is to develop your own video game using virtual reality. Other students choose design and 3D printers — in this case we teach them to create a Rube Goldberg machine.

The process of creating each project must last a minimum of one month to three months, and students come to our makerspaces for two to four hours a week.

What challenges did you have to overcome in building Engidea, and who encouraged you to keep going?
The most difficult challenge is to make known the true objective of creating this type of space, explain why it's necessary, and offer alternatives for all people, including the young people who can't pay our membership fee. My team and my students are vital in helping me show the maker philosophy for this reason. Through social media channels we visualise many of our experiences, events, and workshops.

What are you most proud of in establishing Engidea?
In 2023, we began our scholarship programme, EngiInnova, for young people aged 15 to 19. I am proud because this programme teaches kids and teenagers to create their own ideas using technology, and it doesn't matter what your economic, physical, or psychological condition is.

Last year, we supported 42 kids to bring their creations to regional and national robotics competitions. This year, we plan to go with more scholarship students.

Students at Engidea commit to developing a project over one to three months

> "I AM PROUD BECAUSE THIS PROGRAMME TEACHES KIDS AND TEENAGERS TO CREATE THEIR OWN IDEAS USING TECHNOLOGY

Is there anything else you want to tell Hello World readers?
It doesn't matter where you come from or how many resources you have; the important thing is to know how much you want to create something different to help others.

If you'd like to learn more about Engidea, visit **engidea.com.ve** (HW)

LAURA PANTALÉON

Laura is a mechatronics engineer from Caracas, Venezuela. Her purpose is to teach young people about technology so they can make their own ideas to transform their lives. She is passionate about science, engineering, arts, technology, and social impact through education, which is why she founded Engidea (**lpantaleon@engidea.com.ve, instagram.com/engidea.ve**).

FAVOURITE PROJECTS TO REMIX

Jody Carter speaks with RPF learning managers Pete Bell and Mac Bowley to explore two favourite projects sure to interest young coders

From crafting interactive stories to designing captivating games, the Raspberry Pi Foundation's coding projects offer a hands-on approach to learning, igniting creativity, and developing young people's skills such as perseverance and problem-solving. Each project becomes a canvas for expression, where the power of the imagination is the only limit, and abstract concepts are transformed into tangible creations.

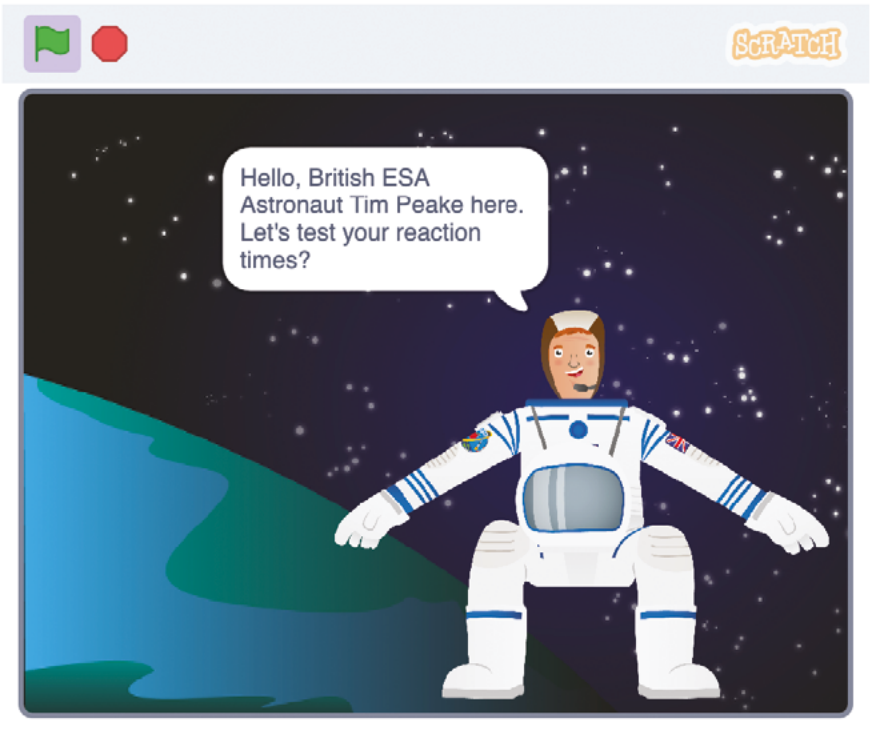
Our projects are free and open to all. They are easy-to-follow, step-by-step guides that young people use to make their own games, animations, and websites using coding languages such as Scratch, HTML/CSS, and Python. The projects introduce coding concepts one by one and let young people build their knowledge progressively. As such, educators and volunteers running clubs don't need to be experienced coders, and many volunteers in our community enjoy learning alongside their club members.

Remixing

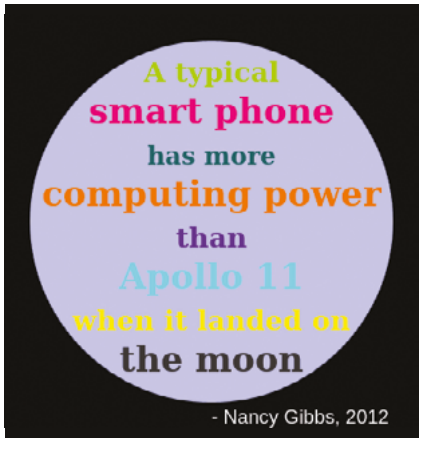
One of the brilliant things about our projects is how easy it is to adapt them. This is called remixing, and it gives the learner the opportunity to create and modify a brand new project that is personal to them. Remixing means that users learn from each other, allowing beginners to tinker with a pre-existing project and make increasingly complex modifications as they become more proficient.

Astronaut reaction times

Pete Bell, learning manager at the RPF, introduces us to one of his favourite projects, which brings space into the classroom. "Space is such an intriguing and mysterious thing, but a really complex concept for young people to get their head around." The vastness of space and the extremely high speeds that satellites and the ISS travel at are difficult concepts for children to understand. The Astronaut Reaction Time Game in Scratch (**helloworld.cc/astronautreaction**) introduces young people to the fact that things happen very quickly at that speed. As Pete explains,



The Astronaut Reaction Time Game gives young people the chance to test their reaction speeds, just like astronaut Tim Peake



Using code to create your own artwork is an excellent way to express yourself

"There are, of course, links to maths and science (speed, distance, time, velocity, units, calculations, operators) and, for older learners, discussions can be had about computational abstractions and problem-solving more widely."

This project tests reaction speeds, something that real astronauts have to do as part of their training. NASA has found that reaction speeds are slower on the ISS than on Earth, possibly as a result of the stress of zero gravity. This project gives young people the chance to test their reaction speeds, just like astronaut Tim Peake. According to Pete, "Linking coding to a fun activity that they can share and play with their friends gives them a taste of the skills required to fly in space." Sharing is a key part of the club environment and this project is ideal for generating a little bit of competition between friends.

> "REMIXING ALLOWS BEGINNERS TO TINKER WITH A PRE-EXISTING PROJECT AND MAKE INCREASINGLY COMPLEX MODIFICATIONS

As with all projects, a scaffolded approach is taken, with challenges set for learners so that they can complete part of the project independently. Hints provide further detail and are themselves scaffolded. If someone is stuck, they can get a hint in the form of an explanation or sentence, which then turns into the code blocks they need to solve the problems, finally giving them the solution if they really need it.

Club volunteers can go further if they wish and introduce their learners to some of our physical computing projects, such as the Python Quick Reaction Game (**helloworld.cc/PythonQuickGame**); or they could design their own race track that measures the speed of a vehicle. They could even develop a program, on a microcontroller like a Pico or micro:bit, to measure the speed of young athletes on a running track. If learners are inspired to do more space-themed projects, we have that covered with our project collection (**projects.raspberrypi.org**).

Colourful creations

Mac Bowley, secondary learning manager, has chosen Colourful Creations as his go-to project (**helloworld.cc/ColourfulCreations**). He explains, "Colourful Creations is a wonderful mix of technology and creativity. Coding is an excellent vehicle for self-expression, and this project showcases the ways programming can be used to create digital art." This project uses the turtle library, which is an excellent tool for creating incredible designs and patterns.

The name 'turtle' stems from the Logo programming language created in the 1960s. Logo is mainly known for drawing lines, shapes, and patterns on the screen, and using a 'turtle' on the floor to draw them on paper. The turtle library is therefore a collection of functions that can be used for drawing.

Mac likes the fact that this project gives learners a blank canvas that they can apply any theme to. "The project is quite light on instructions, leaving lots of space for creativity. Whether it be climate change, a period in history, or some other topic they are learning about, learners can work on their own poster, or they can work in pairs to create something bigger."

Possibilities

The possibilities for remixing are almost endless, as learners can add more screens and turn their project into a mini presentation, or unleash their artistic sides and go wild with colours. The learning in this project leads perfectly into more complex turtle drawing projects like Robo-Trumps — providing a solid foundation in creative computing for you to build on later.

We want you to create your own versions of these projects. You could organise a themed day, which can give learners more freedom, or link with other projects such as Astro Pi (**astro-pi.org**). Try remixing the projects to start with, then building up to develop new and exciting projects based on the skills that have been learnt. Happy coding! (HW)

JODY CARTER
Jody is Code Club Community Coordinator for England and was previously a primary-school teacher.

MALAYSIA: RASPBERRY PIS AND TRAINING FOR SARAWAK PRIMARY SCHOOLS

An ambitious computer science programme is under way in the largest state in Malaysia

In Sarawak, situated on the island of Borneo, the local Ministry of Education, Innovation and Talent Development (MEITD) is funding an ambitious project through which all Sarawak primary schools are receiving sets of Raspberry Pis. Learners use these as desktop computers and to develop computer science skills and knowledge, including the skills needed to create digital making projects.

SUE SENTANCE

Sue is the director of the Raspberry Pi Computing Education Research Centre at the University of Cambridge. Formerly a computing teacher, she leads a number of research projects relating to computer science and AI education, including programming pedagogy and physical computing.

The roll-out

This initiative from the Sarawak government is grounded in using Raspberry Pis as desktop computers in schools, which run offline where schools have no access to the internet. A really important aspect of the project is that teachers are also trained to use the Raspberry Pis to support learners in developing hands-on digital making skills.

Our commercial subsidiary Raspberry Pi Limited (**raspberrypi.com**) works with a company network of approved resellers around the globe; in this case, the Malaysian reseller Cytron has been an enormous support in supplying Sarawak primary schools with Raspberry Pis and other hardware. The ministry combines this hardware distribution initiative with a three-year professional development programme for primary-school teachers. They receive training known as the Raspberry Pi Training Programme, which starts with Scratch programming and incorporates elements of physical computing with Raspberry Pis and sensors.

To date, the project has provided 9,436 kits (with each kit including a Raspberry Pi computer, case, monitor, mouse, and keyboard) to schools, and training for over 1,200 teachers.

The STEM Trailblazers event

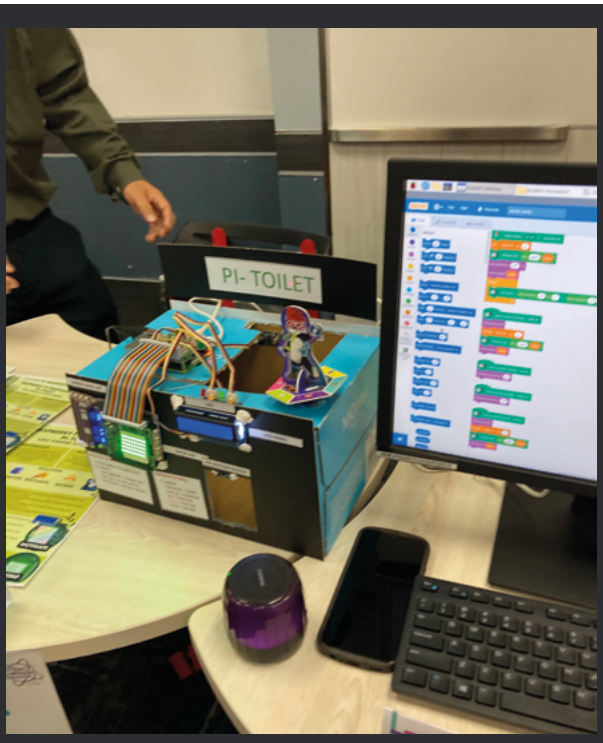
Students and teachers were invited to use their schools' Raspberry Pis to create projects to prototype solutions to real problems faced by their communities. They then showcased these projects at a special STEM Trailblazers event in 2023 (**helloworld.cc/STEMTrailblazers**).

Solving real-world problems

The Raspberry Pi projects at STEM Trailblazers were entered into a competition, with prizes for students and teachers. Most projects had been created using Scratch to control the Raspberry Pi, as well as a range of sensors. The children and teachers who participated came from both rural and urban areas, and it was clear that the issues they had chosen to address were substantial problems in their communities.

What we can learn from this initiative

It's good for us to look beyond our own context, to understand how countries across the world are preparing their young people to engage with digital technology. Everyone involved in this project in Sarawak — including teachers, government representatives, university academics, and industry partners — is committed to giving children the best opportunities to grow up with an understanding of digital technology. They know that this is essential for their professional futures, and also fosters their creativity and problem-solving skills. (HW)



STEM TRAILBLAZERS 2023 STUDENT WINNERS: **PI TOILET**

By mentor Law Sie Tung with students Adam Muizzuddin Bin Hisyamuwandi, Jayvier Wong Huong Zhe, and Felix Law Yee Teng from SJKC Kwang Chien Sarikei school

Greetings! Our Pi Toilet innovation was born out of a daily predicament faced by students — the persistent unpleasant odour in school restrooms. Recognising the nationwide prevalence of this issue, we set out to devise an innovative remedy tailored for educational settings. Moreover, we discovered that our government's emphasis on school restrooms as essential facilities aligned seamlessly with our mission.

While relatively new to Raspberry Pi — accustomed mostly to micro:bit in previous projects — we embraced this change after a [MEITD] workshop at the University of Technology Sarawak revealed Raspberry Pi's potential through GPIO and Scratch capabilities. We made a Pi Toilet that senses the air quality in the toilets to indicate if they need cleaning, and plays music while students clean the toilets to make the experience more enjoyable. The outcome exceeded our expectations, enabling us to successfully implement all desired features and effectively showcase our innovation.

We are elated to share that our collective dedication has yielded remarkable results — the entire system now operates seamlessly, incorporating all envisioned features. This gratifying achievement underscores the potency of innovative ideas, tenacity, and technological synergy.

> TEACHERS HELP LEARNERS TO DEVELOP HANDS-ON DIGITAL MAKING SKILLS

STEM TRAILBLAZERS 2023 TEACHER WINNERS: **PI-REACH KIT**

By teachers Rayderren Bin Benanta, Liana Anak Merikan, and Alex David from Sekolah Kebangsaan Ulu Sungai Naman, Julau

Pi-Reach Stem Education kit is an initiative product by a group of non-STEM teachers. Our team decided to produce the Pi-Reach Kit after collecting initial information through our research on Raspberry Pi usage among teachers in the Julau District of Sarawak. The data showed us that only 7 out of 33 teachers could efficiently utilise the Raspberry Pi kit provided by the MEITD, and the other 26 could utilise it only with proper guidance and instructions. Other data showed that only one school actively used it to create STEM projects, and another 32 schools used it as a regular PC without further exploration. From this information, we realised that the gap in STEM education in rural schools is vast compared to those in urban schools.

Our team has included every component needed to produce fully functional STEM products in these kits. The package includes comprehensive video tutorials and user manual instructions, ensuring a smooth learning experience. Furthermore, each kit includes preloaded code, removing the formidable barrier of coding ability. This design allows even people with no coding experience to embark on their STEM adventure confidently.

SUPER-CURRICULARS TO SUPERCHARGE STUDENT SUCCESS

Teacher **Gemma Moine** and student **Rayhan Manoly** share ideas for super-curricular activities to boost university applications

As an increasing number of students apply to computer science courses at universities, applications are becoming more competitive.

In 2023, the Universities and Colleges Admissions Service (UCAS) reported 94,870 applications for computing-related courses, marking a 9.5 percent increase from the previous year and making it the seventh most popular course in 2023.

This surge is largely driven by a growing interest in computer science. Clare Marchant, former chief executive of UCAS, remarked, "We know that changes in the world around us translate into increased demand for certain courses, as we saw for economics post-2008, and for medicine and nursing during the Covid-19 pandemic. These new figures suggest that students are increasingly inspired to study computing due to the rise of digitalisation and AI."

In addition to achieving the grades to meet entry requirements, having additional knowledge and experience in the field is increasingly important for student university applications. Building a strong portfolio of courses, projects, and research will not only enhance personal statements and aid students in interviews, but will also provide them with hands-on experience in an area of computer science that interests them. This article highlights several ways in which students can access super-curricular activities.

Project-based learning

An excellent way for all secondary-school students to explore the possibilities of recent advancements in technology is by building personalised projects that will help them to develop a broader knowledge base. Online resources such as Massive Open Online Courses (MOOCs) provide students with a foundation to learn new skills, such as a new language or framework, by completing guided projects. Some excellent examples include:

- IBM: Guided Project: Build a Movie Recommender with Django (**helloworld.cc/IBMdjango**)
- IBM: Full Stack Application Development Project (**helloworld.cc/IBMfullstack**)
- MITx: Machine Learning with Python: from Linear Models to Deep Learning (**helloworld.cc/MITMLPython**)

Additionally, tutorials on websites such as YouTube, Coursera, Kaggle, and Udemy offer similar free opportunities for students to develop their software skills. Some of our favourites include:

- Coursera: AI For Everyone (**helloworld.cc/CourseraAI**)
- NeuralNine YouTube Channel (**helloworld.cc/neuralnine**)
- Kaggle: Intro to Machine Learning (**helloworld.cc/KaggleML**)

From there, students can enhance their understanding by applying what they've learnt to their own projects, using documentation and online guides to assist them along the way. Engaging in personal coding projects empowers students to demonstrate their problem-solving skills, creativity, and enthusiasm for technology. Whether it's crafting a mobile app, designing a website, or coding a game, having tangible projects to showcase can significantly enhance students' applications.

Alternatively, using components such as Raspberry Pis or Arduinos enables students to embark on projects involving hardware. Using such components can enable students to create physical projects using sensors, cameras, and servos. Some suggested projects could include:

- Remote-controlled cars
- Environmental data collection and monitoring systems
- Robotic arms

By learning new skills in this way, students not only have their own project to showcase when applying to universities, but they also learn how to navigate more complex code, and how to problem-solve to address issues encountered during program development — skills that will undoubtedly be immensely valuable to them in the future. Moreover, students

Computer-related courses were the seventh most popular UCAS choice in 2023

could adapt these skills and contribute to open-source projects on platforms such as GitHub, demonstrating their ability to collaborate on real-world projects. Both approaches enable students to demonstrate their passion and skills to potential university admissions.

Free university courses/seminars

Universities offer a wide range of free courses in programming, algorithms, data structures, and other computer science fundamentals. These are excellent super-curricular opportunities that are self-paced.

- **CS50 Harvard Introduction to Computer Science course:** covers concepts like abstraction, algorithms, data structures, encapsulation, resource management, security, software engineering, and web development; follow via the official website or the YouTube videos (both are self-paced) (**helloworld.cc/HarvardCS50**)
- **Experience AI:** Raspberry Pi Foundation has a new AI-themed challenge in partnership with Google DeepMind (**experience-AI.org**)
- **CS50 Harvard Introduction to Artificial Intelligence with Python:** explores the concepts and algorithms at the heart of modern artificial intelligence, diving into the ideas that give rise to technologies like game-playing engines, handwriting recognition, and machine translation (**helloworld.cc/HarvardCS50AI**)
- **Stanford Online seminars:** cover a wide range of interesting topics, such as Robotics & Autonomous Systems, Human–Computer Interaction, Algorithmic Fairness, and Client-Side Internet Technologies (**helloworld.cc/StanfordSeminars**)
- MIT courses: there are loads of free downloadable lectures to follow, on topics including Mathematics for Computer Science, Introduction to Computational Thinking and Data Science, Cultures of Computing, and Network and Computer Security (**helloworld.cc/MITopencourseware**)

> “IT’S INCREASINGLY IMPORTANT FOR LEARNERS TO HAVE ADDITIONAL KNOWLEDGE AND EXPERIENCE IN THEIR CHOSEN FIELD

Qualifications

The new CyberEPQ by the Chartered Institute of Information Security (CIISec) is the UK’s first and only Extended Project Qualification (EPQ) in cybersecurity. The EPQ is a Level 3 qualification, accredited by City & Guilds, worth up to an extra 28 UCAS points. The course is delivered using a distance-learning platform (Moodle) and can be studied through your school, or independently (**cyberepq.org.uk**).

The Certified Professional Python Programmer Level 1 certification is the first of the two-series General-Purpose Programming track professional credentials from the OpenEDG Python Institute (**helloworld.cc/PythonInstitute**).

Academic research

Undertaking independent academic research in an area of computer science

Taking part in competitions is a great way to demonstrate your passion

> STUDENTS COULD BENEFIT FROM SUBMITTING THEIR RESEARCH OR PROJECTS TOWARDS THE GOLD CREST AWARD

would enable students to analyse data, form opinions, and discuss the impact on future society. Emerging technologies such as artificial intelligence, brain–computer interfaces, quantum encryption, or Rust programming would serve as excellent starting points. Students can use their academic research to write review articles that could be published in student or academic journals. Journal of Student Research, Young Scientists Journal, and The Concord Review are examples of platforms where students can publish academic research and direct admission teams towards their work.

This can be extended further if your school offers the EPQ; students could benefit from writing an EPQ on a subject related to computer science. As teachers, you can support your students by providing them with inspiration for areas that might interest them, by acting as an advisor, or by assisting them in finding professors or researchers who specialise in the field to advise them.

Students could also benefit from submitting their research or projects to the Gold CREST Award (**crestawards.org**), which is awarded to students who make an original contribution to a STEM field of study. Coolest Projects Online is another excellent platform where learners can showcase work (**coolestprojects.org**).

Work experience, internships, and leadership opportunities

For students interested in how technology is used in business operations, work experience and internships are likely to engage them, while also enhancing their university applications. Industrial placements can help students learn in a variety of ways, such as:

- Being exposed to technologies, languages, and frameworks beyond the scope of the curriculum
- Seeing first-hand how companies use advancements in technologies to solve real-world problems
- Learning about how solutions to problems are made financially viable for business

Technical work experience at a company or research institute can greatly benefit students, though it is important that they are actively involved in something substantial during their time there, as it is that involvement that allows them to learn. This, in turn, enables them to talk in more depth about what they experienced there, which can support them in interviews.

Teachers can guide students by:

- Compiling a list of companies in the local area that can offer internships or work experience, either in person or online
- Assisting students with the application process
- Reaching out to local universities to enquire about opportunities for student mentoring or research projects
- Speaking with the school's IT support department to explore opportunities for mini workshops or research tasks that students could undertake for them

In school, leadership opportunities can arise in various ways. Our school, the British School Al Khubairat (BSAK) runs from Foundation Stage 1 through to Year 13 (ages 3–18), with primary and secondary education on one campus. This set-up is not typical for most secondary schools, however, so it's important to establish a positive working relationship with some of the feeder primary schools. At BSAK, we

encourage our older students to take on a range of leadership roles in primary school, including running workshops for Years 5 and 6 (ages 9–11), which can also be replicated for Key Stage 3 (ages 11–14). Sometimes students struggle to come up with ideas, so we have included a few workshop themes that could help:

- Hands-on intro to hardware components. Let students explore inside an old PC, identifying the CPU, RAM, motherboard, etc. Unscrew an old keyboard and explain how a computer identifies a keystroke.
- Introduce the concept of binary numbers using fun and interactive activities. Use props like coloured beads or cards to represent binary digits (0s and 1s). Challenge learners to decode simple messages using binary.
- Use pixel art to explain pixels and how computers represent colours. Draw and colour fun pixel art pictures and work out file size and colour depth.
- Use Teachable Machine to create fun machine learning models (**helloworld.cc/teachablemachine**).
- Run a mini hackathon. Students could plan, develop, and oversee a small hackathon event. Possible ideas for this include:
  - Scratch or Python challenges focusing on basic programming concepts like loops, conditionals, and event handling.
  - Decrypting secret messages using Caesar ciphers.
  - Visual problem-solving tasks from Bebras (**bebras.org**).

Reading

Reading around the subject is invaluable, whether it be blogs, research papers, or traditional books! It allows students to gain a broader and deeper understanding of the topic by exploring various perspectives, theories, and contrasting viewpoints while developing their own opinions. Some of our personal favourites include:

- *The Code Book* by Simon Singh delves into the fascinating history of cryptography, exploring its evolution from ancient times to the cutting-edge techniques of quantum cryptography.
- *Code: The Hidden Language of Computer Hardware and Software* by Charles Petzold takes readers on a captivating journey through the history and inner workings of computers, from the simplest mechanical devices to modern digital systems.
- *Hello World: Being Human in the Age of Algorithms* by Hannah Fry explores the impact of algorithms on our daily lives, from social media and online shopping to healthcare and criminal justice.
- Quanta Magazine offers over a decade's worth of articles in which reporters focus on developments in mathematics, theoretical physics, theoretical computer science, and the basic life sciences.

Computational thinking competitions

There are a growing number of challenges available online, both in the UK and internationally, that students can participate in to test their problem-solving skills. Entry to these competitions demonstrates a genuine passion for computer science. Some examples include:

- Bebras challenge: students can be registered by their school and participate in the November competition. Students have 45 minutes to tackle a series of interactive tasks, designed to encourage logical thinking and problem-solving skills. If students are lucky enough to be in the top 10 percent, they receive an invitation to participate in the Oxford University Computing Challenge (**bebras.uk**).
- Alan Turing cryptography competition: the annual Turing Competition will encourage every student's inner codebreaker. A weekly challenge, gradually becoming more complex, is set from mid-January through to March (**helloworld.cc/TuringCrypto**).
- Other fantastic options include the Turing Competition's sister competition MathsBombe (**helloworld.cc/MathsBombe**); Southampton University's National Cipher Challenge (**cipherchallenge.org**); or the Perse Coding Team Challenge (**helloworld.cc/PerseChallenge**).

GEMMA MOINE & RAYHAN MANOLY

Gemma is a secondary computer science teacher at the British School Al Khubairat (BSAK) and an advocate for computer science in sunny Abu Dhabi, United Arab Emirates. Rayhan is a Year 12 computer science student at BSAK who intends to pursue computer science at university. He enjoys all aspects of the subject, but is particularly passionate about engaging in projects involving cutting-edge technologies (@**BSAKComputing** @ **BSAKAbuDhabi**).

- Project Euler: a series of challenging mathematical/computer programming problems that will require more than just mathematical insights to solve (**projecteuler.net**).
- A wide range of competitions can be located on the STEM Community website (**helloworld.cc/STEMcompetitions**).

We hope these super-curricular activities enhance your students' UCAS applications and demonstrate their ability to pursue subjects beyond classroom learning. (HW)

ENCOURAGING EMPATHY THROUGH STUDENT-MADE APPS

Discover how a design thinking project can ignite student creativity and instil a sense of purpose, bridging the gap between learning code and its real-world impact

One of the challenges when teaching programming is that students do not see a purpose in it. Some students are motivated by puzzles, solving problems, and making progress, but this does not encourage everyone to learn more, and it certainly does not show the context of why students are learning computing.

This is why, in our school, we introduce a design thinking project early on in a student's coding journey.

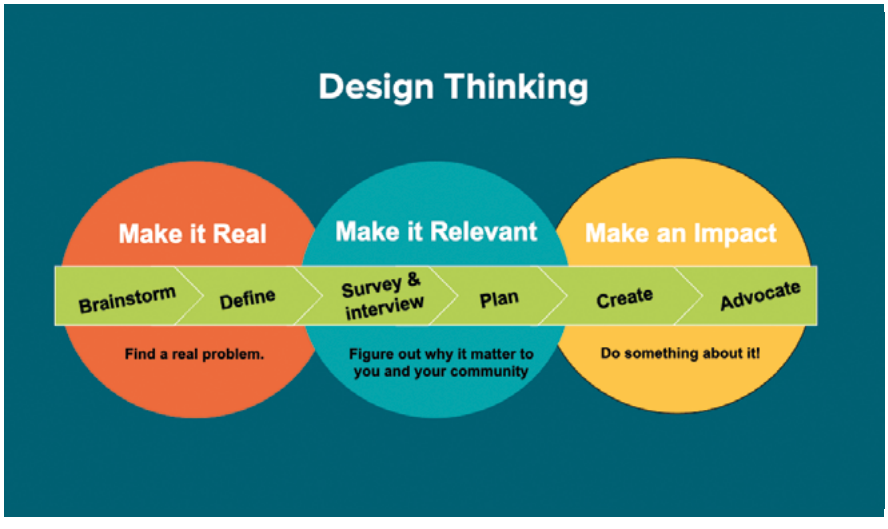
This is done after students have learnt basic selection, iteration, and functions through Python and Turtle. The process of thinking about others and connecting that to the skills they have just learnt is very powerful. I say that it is fine to dream big, and that there might be gaps between what they know now and what they need to learn to do the project. However, I believe that simply going through the design process encourages them to think in an altruistic way.

Design thinking

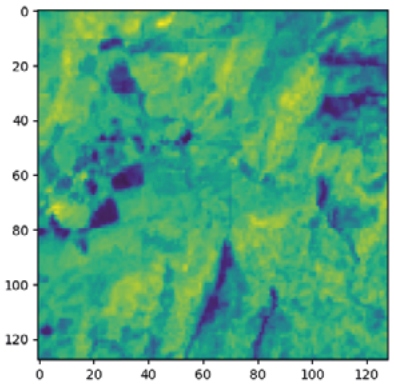
Students are also surprised to see that with very basic skills, they can make a wide variety of projects that can help people, such as quizzes and conversion calculators. I also stress that well-being is a legitimate way to help, and so I am happy to include ideas such as word games and adventure games. Students are encouraged to think about the audience first, but if this does not come naturally to them and they are struggling, asking what they would like to code and then getting them to think about the audience can sometimes ensure they do not get completely stuck. I also offer four sample ideas to ensure that students are not starting from a completely blank page. In many cases, these evolve quickly into ideas that I would never have thought of.

Once the design thinking initial planning is completed, we discuss the gaps in their knowledge, and think about what they would need to do to make the project. In my school's case, they are likely to know basic Python, Scratch, and Python Turtle, which is surprisingly useful for making a simple GUI (Windows-style) app. Using Turtle to make a Windows-style app, or a command line program hosted online, feels like it has authenticity and gives the ability to publish. See this video on making a Python Turtle GUI: **helloworld.cc/PythonTurtleGUI**. Other options that might be suitable for your school include Thunkable, JavaScript, Code.org's studio, Microsoft MakeCode, and Tynker.

However, some projects will take more time, and I tell my students that they might want to save their ideas for the following term, when we teach how to make an app in Swift Playgrounds. In recent versions, you can now make complete apps on Macs or iPads, and even release them to the app store. I note with irony that when Eben Upton released the Raspberry Pi, he told me that it was badly needed, because you couldn't program an iPad. It might be a decade late, but now you can!

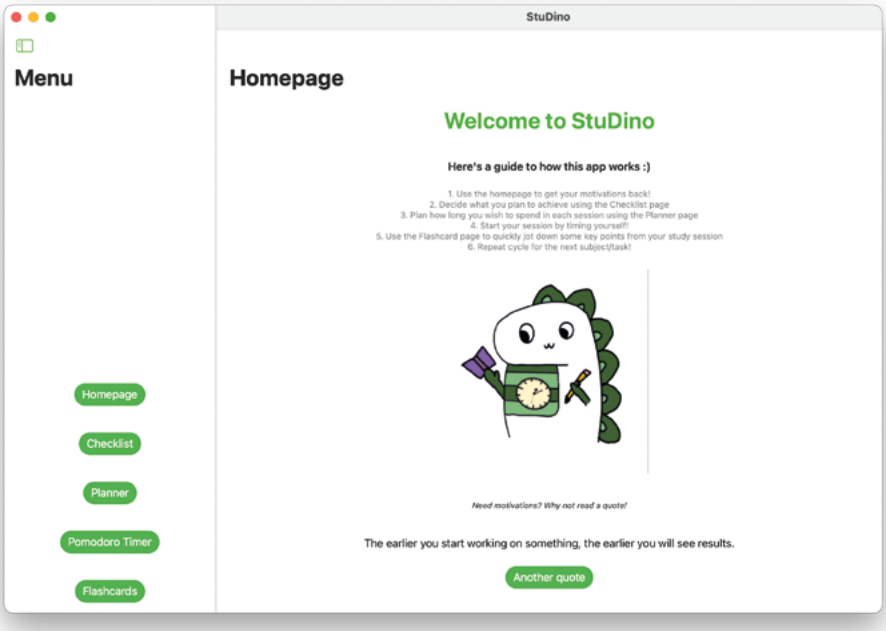


Key design thinking concepts



A landslide data map

Entering mood details on the mood tracking app



Timing to keep you on track

Example student apps

Our students have made a huge variety of projects, and these examples truly illustrate what is possible!

Bryan created an app to help improve students' bedtime routines, and this is now available for free in the app store (**helloworld.cc/BetterBedHabits**). This was his first project, and he then went on to make an even more ambitious project, this time to help forecast where landslides are likely to happen. This initially started as a binary classification model via an SVM algorithm. Then he realised that it needed to be transitioned from this to a convolutional neural network. This was more effective at creating landslide susceptibility mapping. It was also able to take in data on live rainfall and surface temperature, which could be used for warning systems during monsoon seasons. It has already proven itself at detecting high-risk areas such as Batang Kali (Malaysia), which recently suffered a large landslide. These projects helped Bryan to get an unconditional offer from Harvard University.

Carmella (**helloworld.cc/21**, pages 30–31) is keen to study psychology at university, and so she made a mood-tracking app. It is designed to aid emotional awareness and well-being. Through this app, you can document your current emotional state by selecting one or more words from a list of emotions and gauge the intensity on a slider scale. This app encourages users to engage regularly with their emotions and provides tools for self-reflection, aiming to facilitate personal growth and resilience. Users can share the records on this app with a trusted friend or counsellor to discuss their emotional well-being. However, all data is kept on-device and no data is shared.

Dhivyesh is using the Raspberry Pi to detect number plates and then display the name of the child that needs to be picked up. This project is a great combination of artificial intelligence and hardware (see the simple video tutorial on Computer Vision: **helloworld.cc/simpleAIvision**).

Other apps include Stu Dino, made by Emily, which helps students with dyslexia study more effectively by using timers; and Zeitplan, by Adit, which uses the camera to make your to-do list rather than needing to write tasks down.

Each of these projects encourages a sense of citizenship and authentic context that is not always apparent in computing lessons, and gives every student a chance to make an impact. (HW)

> PROJECTS CAN BE CREATED USING VERY BASIC SKILLS

JAMES ABELA

James is the head of computing at Garden International School in Kuala Lumpur, Malaysia. He is a Raspberry Pi Certified Educator, founder of the South East Asian Computer Science Teachers Association, and author of *Creating SwiftUI Apps in Playgrounds* (**@eslweb**).

TEACHING ELECTRICITY USING PROGRAMMING AND THE MICRO:BIT

Faheemah Vachhiat shares her insights and pedagogical approaches in creating a six-week cross-curricular unit of work

As a primary-school teacher, I am always on the lookout for engaging and interactive ways to teach. Our topic was electricity this term, and I wanted an interactive way to test the conductivity of materials. I decided to use the BBC micro:bit — a microcontroller with built-in sensors and LEDs — to make the learning process fun and hands-on. Over six weeks, I planned and implemented a unit of work that combined programming and teaching electricity using the micro:bit. In this article, I will share my experiences and insights, including the pedagogical approaches I used (helloworld.cc/teachingprogramming) and the targeted activities that supported my teaching.

Week 1: introduction to programming concepts

In the first week, I introduced my students to basic programming concepts, such as algorithms and variables. To engage them in the learning process, I used a range of interactive activities, including unplugged games and puzzles. For example, I introduced the concept of algorithms using a step-by-step approach on how to make a sandwich or a squash drink, in which students had to write down each step of the sequence.

Algorithms and flowcharts

We discussed how algorithms are a set of instructions that are used to solve a problem, and how flowcharts can be used to model algorithms. To help students understand algorithms, we worked through several examples of simple algorithms and created flowcharts to represent them. We then moved on to more complex algorithms, including loops and decision-making.

Activity example

- Students worked in pairs to make a sandwich or a squash drink
- They wrote down each step of the routine in sequence, using a flowchart
- They swapped routines with another pair and tried to perform the action using the written instructions

Outcome

Students were able to understand the concept of algorithms and write down a series of steps in sequence.

Week 2: exploring patterns with LED lights using microcontrollers

In the second week, we explored physical computing with microcontrollers, specifically the micro:bit. I used live coding and PRIMM pedagogical approaches to help students understand the concepts. Live coding involves modelling programming techniques and thought processes in front of students, while PRIMM involves learners using a sample program to predict output and then modifying it to create their own program.

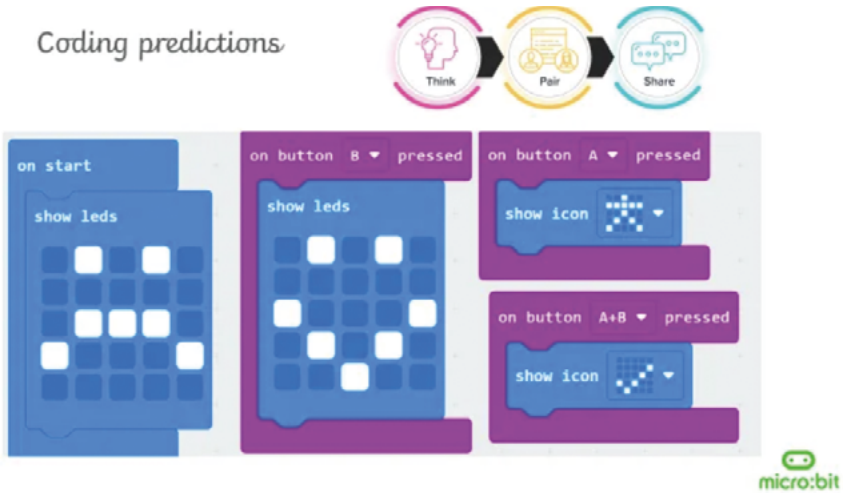


Figure 1

Students worked in pairs and groups to learn about programming and electricity

- **Predict:** I started by sharing a sample program with the students, such as a simple program that turns LED lights on and off in a loop. I asked the students to predict what they thought the program would do and what each line of code did (**Figure 1**).
- **Run:** I then ran the program and showed the students what it did. We discussed whether the program did what they expected and whether they noticed anything interesting about how the lights turned on and off.
- **Investigate:** next, I asked the students some carefully constructed questions to help them better understand the program. For example, I asked them what each line of code does, why we need the 'forever' loop, and what would happen if we changed the timing of the loop.
- **Modify:** I then guided the students through modifying the program in a way that built on their understanding of the concepts, using the live coding method. For example, I modelled to them how to change the pattern of the lights and then allowed them to explore making their own patterns.
- **Make:** finally, I asked the students to create their own program using the concepts they had learnt. For example, I asked them to create a program that made the lights blink in a specific pattern, or to create a program that used the buttons on the micro:bit to control the lights (**Figure 2**).

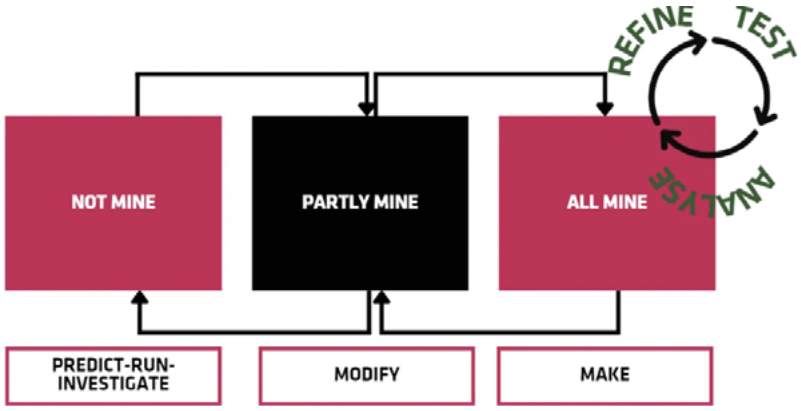


Figure 2

Throughout each stage, I encouraged classroom discussion to help enhance social learning and to ensure the students were engaged and understood the concepts.

By using the PRIMM approach, I believe that students gained a deeper understanding of programming concepts and were better equipped to create their own programs.

Outcome

Using these approaches, students were able to create visually stunning LED light patterns using the micro:bit and basic coding skills.

Week 3: targeted tasks

In the third week, I used targeted tasks to focus my students on specific learning goals, such as programming initialisation. We used a range of activities, such as changing aspects of programs, investigating and fixing code, and following instructions. I provided feedback on their work and scaffolded the learning experiences.

One example of a targeted task was investigating and fixing code. In pairs, students worked to identify and fix a bug in a given program. We used a flowchart to help students understand the cause of the bug. The students then wrote new code to fix the bug, and tested the program. This activity was a great way to help students understand how to troubleshoot and problem-solve in programming.

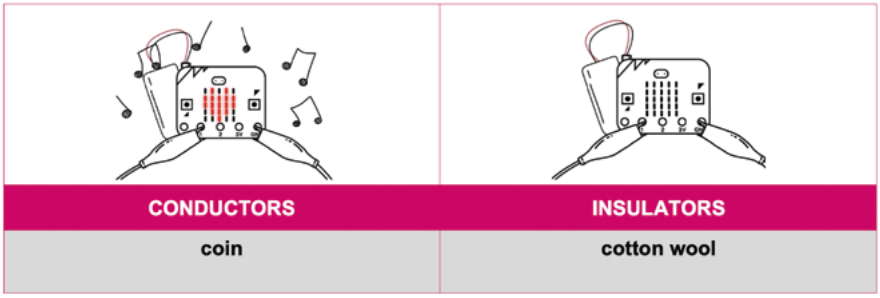


Figure 3

Activity example: investigating and fixing code

- Students work in pairs to identify and fix a bug in a program
- They use a flowchart to identify the cause of the bug
- They write a new code to fix the bug, and then test the program

Outcome

Students were able to identify and fix a bug in a program, using a flowchart to help them understand the cause of the bug.

Week 4: Parson's Problems

In the fourth week, I used Parson's Problems as a targeted task to help my students understand programming patterns and concepts. Parson's Problems are programming problems in which the code is provided, but jumbled up in a way that requires students to put it back in the correct order. This activity helps students develop their programming skills, as well as their ability to read and understand code.

Activity example: Parson's Problems

I provided students with a Parson's Problem that required them to write a program that would light up specific LEDs on the micro:bit. The code for the program was provided, but in the incorrect order. Students were asked to rearrange the code into the correct order to make the program work. They then tested the program on the micro:bit and checked to see if the LEDs lit up as intended.

Outcome

Students were able to identify the correct order for the jumbled code and write a program that lit up specific LEDs on the micro:bit. This activity helped them develop their programming and problem-solving skills, as well as their ability to read and understand code.

Week 5: inputs and outputs and flowchart modelling

In the fifth week, we focused on inputs and outputs, and used flowchart modelling to plan our programs. We discussed how inputs and outputs are used in programming and how we could use the micro:bit to control them.

Activity example: conductivity testing

Students worked in pairs to explore which materials conducted electricity. They used a flowchart to plan their experiment and record their results.

1. I introduced the concept of conductivity and how it relates to electricity (**Figure 3**).
2. A range of materials was provided for students to test, such as paper clips, coins, and pencils.
3. A flowchart guided students through the process of testing each material and recording their results.

Outcome

Students were able to plan and conduct an experiment to explore conductivity, and used a flowchart to model the process of their program (**Figure 4**).

Week 6: group project

In the final week, we worked on a group project in which students had to create a program that used the micro:bit to conduct electricity. They had to incorporate into their program all the programming concepts they had learnt during the unit.

I showed the class that at the bottom of a micro:bit are five large pins. When you connect pin 1 and the GND or ground pin with a crocodile clip lead, it completes an electrical circuit. If you attach two crocodile clip leads, one to pin 1 and one to the GND pin, you can put a material such as silver foil or cling film between the ends of the two leads to test whether the material is conductive, or an insulator.

In this project, children had to use selection. If an electrical circuit is made (because the material conducts) then the micro:bit will show a heart on its LED display and play the note middle C.

If a circuit is not made, the micro:bit will clear its LED display and a note will not play — the micro:bit is instructed to play a note at a frequency of 0Hz.

The program uses a 'forever' or infinite loop, so it keeps testing until you disconnect the micro:bit from a power supply.

First I showed the children how to create and use a flowchart, to help them create this code (**Figure 5**).

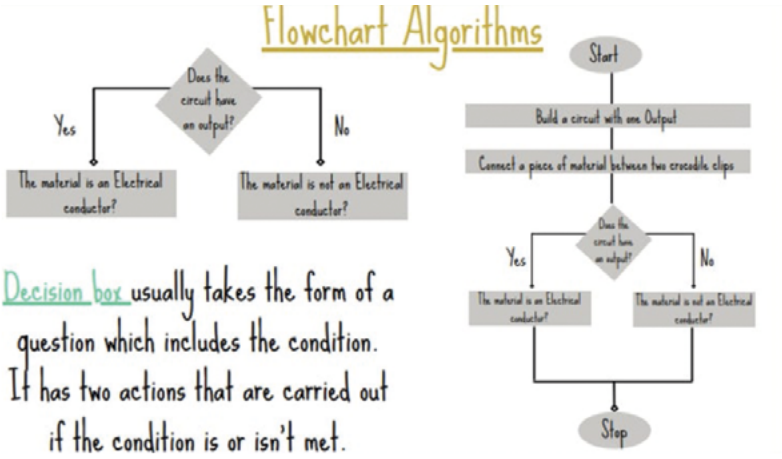


Figure 4

The micro:bit is an engaging tool for teaching physical computing

I then demonstrated how to use block-based coding by showcasing a program that used the micro:bit's touch sensor (P1) to trigger actions. This program displayed a heart icon and played a tone when the touch sensor was pressed (**Figure 6**).

The specific blocks used in this part are:

basic.forever() block: this block is used to continuously run the code
input.pinIsPressed() block: this block checks if the touch sensor (P1) is pressed
basic.showIcon() block: this block displays the heart icon

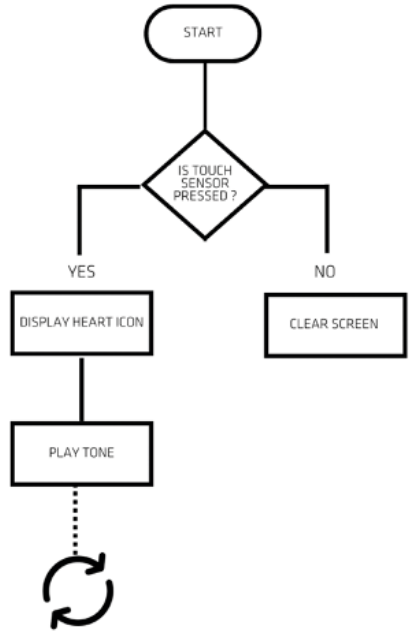


Figure 5

music.ringTone() block: this block plays a tone
basic.clearScreen() block: this block clears the LED display

Finally, I provided learners with some time to work on their own, with my support and guidance, to program the micro:bit to display the results of their experiment. I checked in with each group to answer any questions they had and provide feedback on their programming.

Outcome

This activity was a great way to introduce students to the world of physical computing and help them develop important skills in programming, problem-solving, and critical thinking. With the right guidance and support, my students were able to create their own programs and experiment with the micro:bit in exciting and engaging ways. Students were able to plan and conduct an experiment to explore conductivity, and used a flowchart to model the process of their program.

Conclusion

The outcomes of this unit were highly positive, with my students showing a greater level of engagement and enthusiasm towards programming and physical computing. They were able to apply their knowledge and skills in creating their programs and experimenting with physical computing concepts.

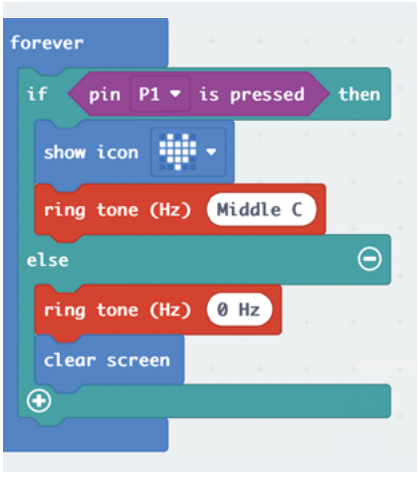


Figure 6

Overall, I highly recommend the use of the micro:bit as a tool for teaching physical computing and programming concepts to primary-school students. The use of pedagogical approaches such as live coding, PRIMM, and targeted tasks, along with the use of visual aids and hands-on experimentation, can lead to highly effective learning outcomes. (HW)

FAHEEMAH VACHHIAT

Faheemah is an accomplished primary-school teacher with over ten years of experience. She is currently responsible for overseeing the computing curriculum at her school, and she is always seeking new ways to inspire her students and help them excel.

LESSON PLAN

The following lesson plan is taken from the 'Impacts of Technology' unit of The Computing Curriculum (TCC), written by the Raspberry Pi Foundation. It is aimed at learners aged 14–16, and is designed to help students learn how to identify the specific type of impact technology has on us, i.e. legal, cultural, privacy, environmental, and ethical. Learners will begin to understand the legal impact of technology specifically, and work through an example relating to the Data Protection Act (2018).

ABOUT THE COMPUTING CURRICULUM

Raspberry Pi Foundation

The Computing Curriculum is the Raspberry Pi Foundation's bank of free lesson plans and other resources that offer educators everything they need to teach learners aged five to sixteen. It covers the full breadth of computing, including computing systems, programming, creating media, data and information, and societal impacts of digital technology.

Every unit of work contains a unit overview; a learning graph to show the progression of skills and concepts in a unit; and lesson content, including a lesson plan, slides, and formative assessment opportunities. Find them when you sign up for a free account at **helloworld.cc/tcc**.

HOW DOES TECHNOLOGY IMPACT US?

Explore five broad areas of impact and dive deeper into the legal impact of tech through the Data Protection Act

AGE RANGE

14–16 years

OBJECTIVES

- Apply the terms 'privacy', 'legal', 'ethical', 'environmental', and 'cultural'
- Explain data legislation, including an organisation's obligation to protect and supply data

This is the first lesson in The Computing Curriculum's 'Impacts of Technology' unit introducing the subject of the impact of technology. Learners will identify and discuss the impact areas through genuine examples. They will begin to understand the legal impact of technology specifically, and work through an example relating to the Data Protection Act. (HW)

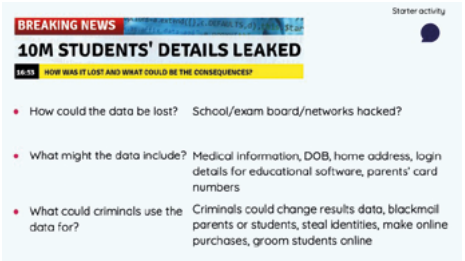


Figure 1

STARTER ACTIVITY: SHOCK HEADLINE RELATING TO DATA PROTECTION BREACH OF LEARNERS' DATA 5 MINUTES

Share a fake headline with learners that suggests that there has been a breach of 10 million learners' data records. Ask them to discuss with a partner how data could be lost and what the consequences could be. Next, hold a class discussion, scaffolded by the questions below:

- How was the data lost? For example, could the school network have been hacked?
- What if the data included medical information, dates of birth, home addresses, and login details for educational software?
- Could criminals use that information to change results data, blackmail parents or learners, or steal identities and impersonate learners for criminal purposes?

ACTIVITY 1: WHICH CATEGORY OF IMPACT RELATES TO THIS DEFINITION/EXAMPLE? 15 MINUTES

Share with learners the icons of the categories of impact in **Figure 2** and ask them, in pairs, to write possible definitions of the categories, to gauge their early understanding of the topic. Then share the definitions in **Figure 3**.

Figure 2

Next, hand out the 'Impact categories' worksheet available at **helloworld.cc/impactoftech-lesson**, or use **Figure 4** to share examples of headlines about a genuine impact from each category. Ask learners to work in pairs to match the category with the example and describe the potential impact of each event.

Discuss each example as a class, including more details of the news stories, to expand learners' understanding and ability to link technology with stakeholders and categories. The concept of stakeholders is discussed in more depth in a subsequent lesson.

Activity 1

Categories of impact

Category	Explanation
Legal	Technology provides opportunities to criminals. To help protect people, their data, and their work, several laws have been introduced in the UK.
Environmental	The effect that technology has on the world around us
Cultural	How have society and the ways that we interact been impacted?
Ethical	Considerations about right and wrong, morality and power
Privacy	Once data is put on a computer, it can be easily copied or shared. In some cases, people have a right to choice in this matter.

Figure 3

Activity 1

Categories of impact: best fit?

	Example	Category?
1	Hackers hit A-list law firm of Lady Gaga, Drake and Madonna	
2	In 2017, China built a 250-acre solar farm shaped like a giant panda	
3	Digital technology is fuelling a loneliness epidemic (Age UK)	
4	Artificial intelligence: Algorithms face scrutiny over potential bias	
5	Apple Martin tells off mother Gwyneth Paltrow for sharing photo (of Apple) without consent	

Ethical
Privacy
Legal
Cultural

Figure 4

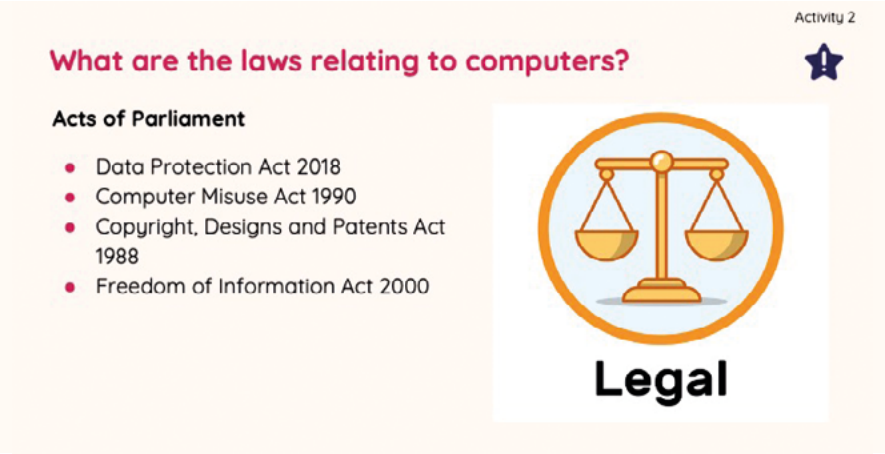


Figure 5

ACTIVITY 2: LIST OF LAWS RELATING TO COMPUTING AND INTRODUCTION TO DATA PROTECTION 10 MINUTES

Share **Figure 5**, which shows a list of Acts of Parliament in the UK.

Point out the purpose of the Data Protection Act. The 1998 Data Protection Act was passed by parliament to control the way that data is handled and to give legal rights to people who have information stored about them. This was then replaced by the updated 2018 act, which further tightened data privacy laws.

Explain that this particular impact has the most factual information that needs to be committed to memory, so this lesson will focus on the Data Protection Act, and subsequent lessons will go into more detail about the impact of the other laws.

Briefly explain who data subjects are (everyone). We all have data stored about us and have the right to have that data looked after properly, and the right to see the data. This is called the 'right of subject access'.

Then explain the role of the Data Controller (DC) and the Information Commissioner's Office (ICO). The DC is the person who is responsible for ensuring that the organisation's actions stay within the principles of the Data Protection Act. The ICO makes sure that the companies keep to the rules, and fines those that don't, sometimes heavily.

Finally, share the six principles of the Data Protection Act shown in **Figure 6**.

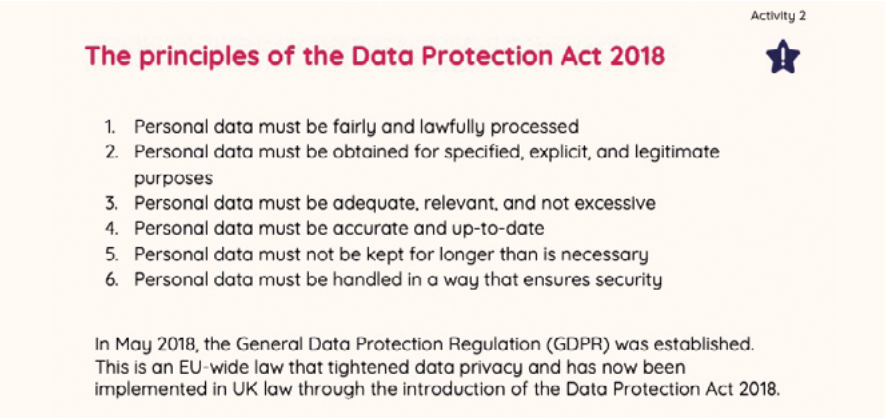


Figure 6

Applying data protection at Sophia's farm

Introduction

Sophia has a small farm that provides fresh produce to local customers. She intends to set up a new website featuring her produce and allowing customers to sign up for a weekly delivery to their home. What are the issues relating to the data protection principles that Sophia should consider?

The Data Protection Act is summarised here: https://www.gov.uk/data-protection

Issue	Description	How it relates to the DPA. Personal data must...
e.g., What data will Sophia collect?	*When customers initially sign up for their deliveries, she must consider what data is needed to deliver the correct items to the correct address — no more and no less.*	*...be adequate, relevant, and not excessive (DP3).*

Figure 7

ACTIVITY 3: APPLICATION OF DATA PROTECTION PRINCIPLES TO SOPHIA'S FARM WEBSITE 17 MINUTES

Learners will apply their developing knowledge of data protection to the case study of a farmer (Sophia) who is collecting and using data for home deliveries. Hand out the 'Applying data protection at Sophia's farm' worksheet available at **helloworld.cc/impactoftech-lesson** or refer to **Figure 7**, which gives an example of one of the principles and leaves space for learners to explain the other five principles in the context of the case study.

Give learners ten minutes to work through the worksheet themselves, then spend five minutes discussing the answers as a class, and ensure that learners expand their answers on their own worksheet.

PLENARY ACTIVITY: 3-2-1 UNDERSTANDING CHECK 7 MINUTES

Check students' comprehension by asking them to write their answers to the following questions on a sticky note:

- Three things I have learnt
- Two things I knew already
- One question I still have to study

Ask learners to hand in their sticky notes for assessment and reflection.

RELEVANT LINKS

TCC 'How does technology impact us?' lesson:

helloworld.cc/impactoftech-lesson

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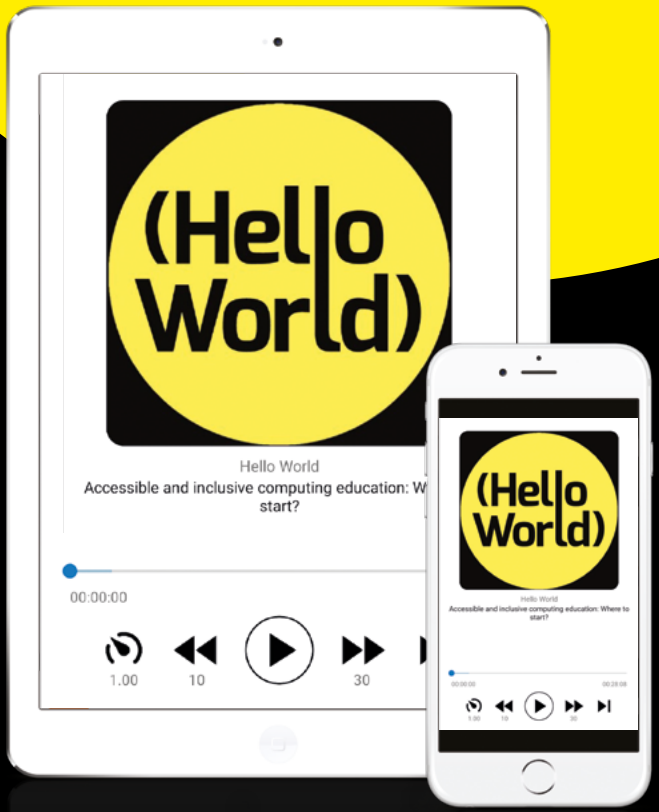


OUR MOST POPULAR EPISODES

How moral is your machine? Ethics in computing education

Accessible and inclusive computing education: where to start?

How can we get everyone excited about code?

THE BEBRAS PUZZLE PAGE

Each issue, **Andrew Csizmadia** shares a computational thinking problem for your students based on the work produced by the International Bebras Community

ABOUT BEBRAS

Bebras is organised in over 71 countries and aims to get students excited about computing and computational thinking. Last November, over 408,000 students participated in the UK annual challenge. Our archived questions let you create your own automarking quizzes at any time during the year. To find out more and to register your school, head to **bebras.uk**.

THE PROBLEM: BEAVERS VS. KANGAROOS

DOMAIN

Algorithms and programming

SKILLS

Algorithmic thinking, pattern recognition

AGE

12–19 years

DIFFICULTY RATING

Ages 12–14 hard;
Ages 14–16, medium;
Ages 16–19 easy

While crossing a swamp by using a log path, five beavers meet a group of kangaroos going in the other direction. Nobody wants to become wet or dirty, so they stay on the path. The kangaroos discover that from one specific log, it is possible to jump onto a stone next to the log path, and jump back to that one log. However, only one kangaroo can stand on the stone at a time.

The kangaroos and beavers don't mind going all the way back, except for Fred, the lead beaver, who is the first to meet the kangaroos. Fred only wants to take a step back ten times.

Task

How many kangaroos can pass Fred without taking a step back?

a) More than ten kangaroos
b) Exactly ten kangaroos
c) Exactly six kangaroos
d) Exactly four kangaroos
e) It is not possible to determine

Further information

Algorithms are essential to the way computers process data and complete task steps in a specific order.

- **Changing the content of a variable:** each log, and the stone, is a place where information can be stored as in a variable and the beavers and the kangaroos are the data to be stored
- **Ordering of the steps:** there must be some arrangement for the kangaroos to pass the beavers by moving them to different places; as they cannot pass directly, creating a schedule helps to solve the problem
- **Repeating necessary steps:** in this case, the same sequence of movements is repeated several times, which is a typical concept of computational thinking: solve a small problem once, and repeat the solution as often as necessary

Thus, an algorithm can be considered as any sequence of operations including repetitions that can be simulated by a computer system. Recognition of patterns in algorithms (similar steps that are repeated) can be turned into reusable code for a quick and automatic solution of a problem (as the formulation here). The logs and the stone are like registers in a computer processor that can store data.

This Bebras puzzle was originally written by the Bebras team from Vilnius University in Lithuania. Solution on page 79.

COMPUTING KEYWORD SPOTLIGHT: ALGORITHMIC THINKING

Defining words and phrases in computer science

Algorithmic thinking is the ability to think in terms of sequences and rules as a way of solving problems. Some problems are one-off; they are solved, solutions are applied, and the next one is tackled. Algorithmic thinking needs to kick in when similar problems need to be solved repeatedly. They do not have to be thought through anew every time; the solution works every time. Learning algorithms for doing multiplication or division is an example. If simple rules are followed precisely, by a computer or a person, the solution to any multiplication can be found. Once the algorithm is understood, it doesn't have to be worked out from scratch for every new problem. Algorithmic thinking is a core skill that students develop when they learn to write their own computer programs. (HW)

MEET THE CODE CLUBS

Jody Carter chats with two Code Club leaders in England

Code Clubs offer a platform for young learners to delve into the world of coding, fostering creativity, critical thinking, and collaboration. As coding continues to shape the future, Code Clubs stand at the forefront, helping to give every child the skills, confidence, and opportunity to change their world. In this article, we'll meet some Code Clubs and hear about their role in shaping tomorrow's makers, and the transformative experiences they offer to aspiring coders.

Laura Holborow
Lethbridge Primary School, Swindon, UK

Why did you start a Code Club?
I started the Code Club when I left teaching computing to work full-time at the Raspberry Pi Foundation. I wanted to continue to have hands-on experience in the classroom working with young people to develop their skills. One of the great things about running the Code Club is that I get to see first-hand young people working on the projects.

What projects are children working on?
Most children in the club work on the Scratch pathways. We always start the term with the 'Intro to Scratch' pathway and the children collect stickers as they complete the project. The children can then decide whether they want to continue to work on Scratch projects or if they want to explore other projects in Python or HTML. Children also take part in competitions such as Astro Pi Mission Zero, in which they write code that is run on the International Space Station. We have also experimented with some physical computing with micro:bits!

The children work on various projects depending on their interests and skill level

What makes your club special?
The club is very popular with children at the school, so we open it up to new members each term to ensure everyone who wants to join can take part at some point during the year. The children who attend are engaged because they get to try something new each week and collect a new sticker — let's face it, who doesn't love a sticker?

What does a Code Club session look like?
I normally start each session with a quick recap on what we did last time, and I then introduce a project that children could work on during the session if they want to. The children then make a start and I move around the room looking at what they are doing and helping them if they need it. At the end of the session, we always do a 'share my project' session in which children who want to get the chance to share what they have done with the other children in the group. The children are really great at supporting each other and learning from each other.

Describe your club in three words.
Fun, creative, and supportive.

LAURA HOLBOROW
Laura is a senior learning manager who leads a team developing curriculum resources for educators based in the UK. She is passionate about improving uptake and engagement amongst underrepresented groups in computing. Laura runs a Code Club at her daughter's primary school to promote computing and have fun experimenting with code and physical computing.

Lin Vong
Camberwell Code Club, London, UK

We spoke to Lin Vong, who runs Ignite Hubs and is a Code Club Leader at Camberwell Code Club. Lin first started Peckham Code Club in 2019 after her daughter's club ended. Since then, Lin has helped grow Ignite Hubs from 1 to 80 volunteers, supporting up to 100 children each week at five libraries throughout Southwark, in London. The average age of attendees is 11–12 years old.

Why did you start a Code Club?
I feel it is important that all children have the opportunity to learn coding. As the world becomes more digitalised, understanding how to code will become increasingly important to access future opportunities.

What projects are children working on?
The children work on various projects depending on their interests and skill level. We recently introduced micro:bits, and they have really enjoyed using them to improve their coding skills. I think they like the resources because they are well laid out, and there are a lot of projects for them to choose from.

What does a Code Club session look like?
The room has different tables dedicated to specific programming languages, such as the Scratch table. This set-up enables the children to collaborate, learn, and support each other. Towards the end of each session, we have a 'show and tell' segment, which is a great way for the children to see each other's work and celebrate their progress and achievements.

Describe your club in three words.
Inspiring, fun, and supportive. (HW)

Code Clubs offer the opportunity to try something different each week

LIN VONG

Lin is a finance professional. She lives in London and is a mum to two children. She is passionate about Code Club and helping children and young people access learning experiences that prepare them for a digital world and gain the skills needed for future employment in STEM.

DELIVERING EXPERIENCE AI LESSONS

Laura James shares advice on using Experience AI to teach students about artificial intelligence

Developed by the Raspberry Pi Foundation and Google DeepMind, Experience AI (experience-ai.org) provides teachers with free resources to confidently deliver lessons that will inspire and educate young people about AI and the role that it could play in their lives.

I recently delivered these lessons to three Year 9 classes (ages 13–14) of about 20 students each with a ratio of approximately 2:3 girls to boys. They are keen pupils who have elected to study computing as an option.

Lesson plans

The Experience AI lessons are an excellent set of resources. They are a series of six lessons which introduce the concepts behind machine learning and artificial intelligence. There are full lesson plans with timings, clear slides, and activity sheets. An end-of-topic multiple-choice assessment is also provided.

Accompanying these lessons are interesting, well-produced videos that underpin the concepts, all explained by real people who work in the artificial intelligence industry. There are also helpful videos for educators, which explain certain parts of the scheme of work — particularly useful for parts that might have been seen as difficult for non-specialist teachers, such as setting up a project using the Machine Learning for Kids website (**machinelearningforkids.co.uk**).

LAURA JAMES
Laura James is the head of computing & ICT at King Edward's School in Bath, UK. Previously a programmer, Laura has spent the last ten years working in secondary education.

Confidence delivering lessons

The clear and detailed resources meant I mostly felt confident in delivering lessons. The suggested timings were good guidelines, although in some lessons the timing did not always go to plan. For example, when the pupils were enjoying investigating websites that produce images generated by a text prompt, they were keen to spend more time on this than was allocated in the lesson plan. In this case, I modified the timings on the fly and set the final task of the lesson as a homework task.

Learning about artificial intelligence sparked students' curiosity and triggered a few questions that I could not answer immediately. However, I admitted this was a new area for me, and with some investigation I found answers to many of their extra questions. This showed me that the topic of AI is such an inspiring and important one for the next generation, and how important it is to add this to the curriculum now, before students form their own, potentially biased, opinions about it.

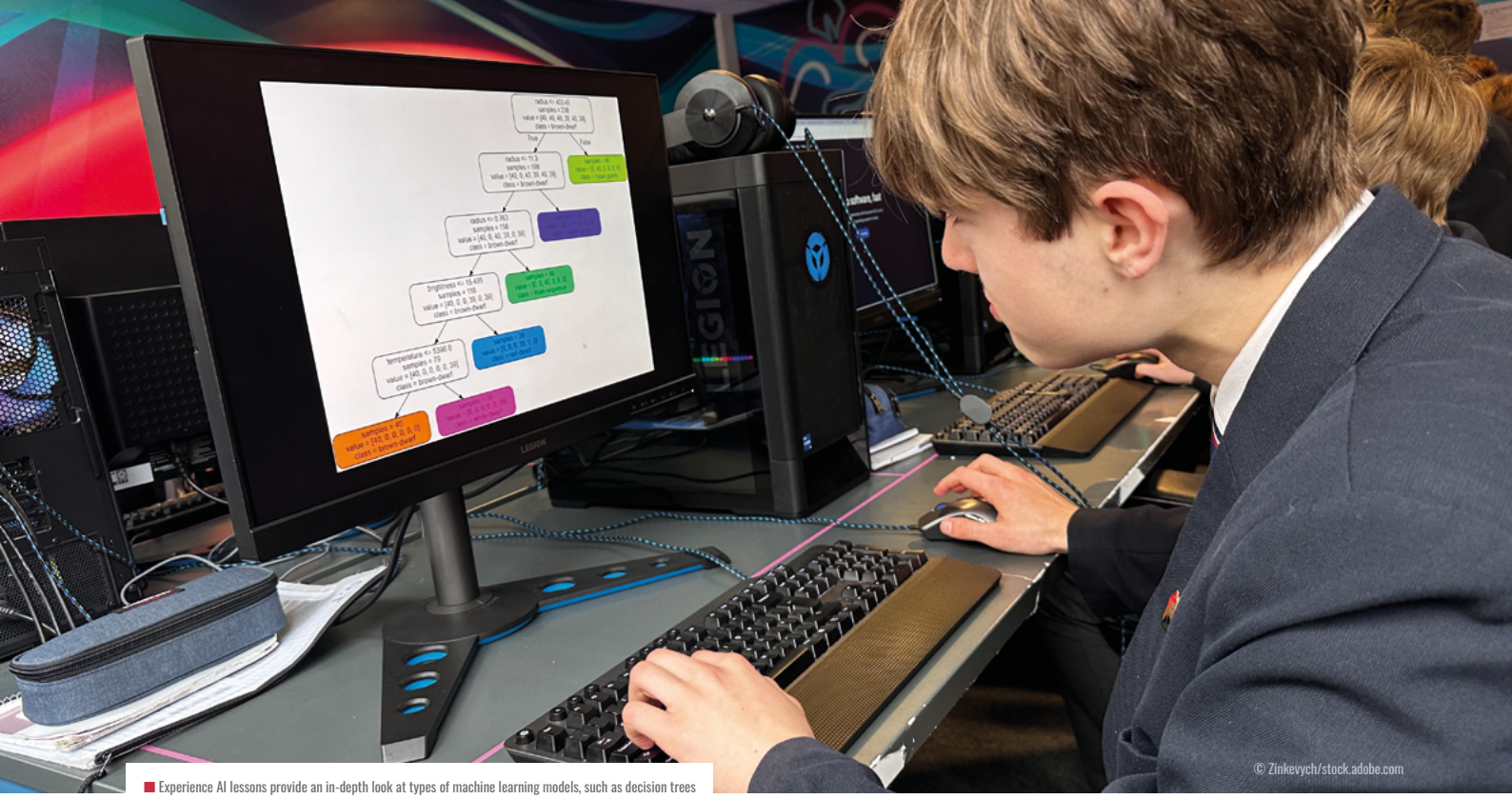
Impact

Feedback from pupils about the series of lessons was thoroughly positive. I felt that the lessons on bias in data were particularly important. The lesson where they trained their own algorithm to recognise tomatoes and apples was a key one, as it gave students an immediate sense of how a flawed training data set creates bias and can impact the answers from a supposedly intelligent AI tool. I hope this has changed their outlook on AI-generated results and reinforced their critical-thinking skills.

Many students are now seeing the influence of AI appearing in more and more tools around them and have mentioned that they are now interested in a career in AI.

To other educators

Clearly this topic is incredibly important, and the Experience AI series of lessons is an excellent introduction to this for KS3 (ages 11–14) students. Here are some tips for other educators.



Experience AI lessons provide an in-depth look at types of machine learning models, such as decision trees

- I delivered these to bright Year 9s (13- and 14-year-olds) and added a few more coding activities from the Machine Learning for Kids site. As these lessons stand, they could be delivered to Year 8s (12- to 13-year-olds) but Year 7s (11- to 12-year-olds) might struggle with some of the more esoteric concepts.

- Before each lesson, read the content and familiarise yourself with the lesson resources and tools used. The Machine Learning for Kids website can take a little getting used to, but is a powerful tool that brings to life how machine learning works, and many pupils said this was their favourite part of the lessons.

- Before the lesson, ensure that the websites you need to access are unblocked by your school's firewall.

> LEARNING ABOUT ARTIFICIAL INTELLIGENCE SPARKED THE STUDENTS' CURIOSITY

- I tried to add a hands-on activity to each lesson, e.g. for Lesson 1 I showed them Google Quick, Draw! (**quickdraw.withgoogle.com**), which they enjoyed. It has a good section on the training data they used to train the AI tool to recognise the drawings.

- We also spent an extra lesson using the brilliant Machine Learning for Kids website and followed the 'Shoot the Bug' worksheet, which allowed pupils to train an algorithm to play a simple video game.

- I also needed to have a weekly homework assignment, so I would either use part of the activity from the lesson or quickly devise something (e.g. research another use for AI we hadn't discussed, or look at what ethical issues might occur with a certain use of AI). Next year, our department will formalise these to enable other teachers to set these tasks more easily.

- I needed to have a summative assessment at the end of the topic. I used some of the multiple-choice questions that were provided, but added some longer-answer questions and made an online assessment to allow me to mark their answers more efficiently.

STUDENT FEEDBACK

"I've enjoyed actually learning about what AI is and how it works because before I thought it was just a scary computer that thinks like a human."

"I have always been fascinated by AI applications such as ChatGPT or DALL-E and finally finding out how they work and make the decisions they do has been a really cool experience."

"I enjoyed learning the theory behind how an AI makes decisions using the data it has."

From comments I have had from the students, it's clear they really engaged with this and appreciated the opportunity to discuss and explore the topic, which is often associated with deception within school. It allowed them to understand the benefits and the risks of AI and, most importantly, to begin to understand how it works under the hood, rather than seeing AI as a magical anthropomorphised entity that is second-guessing their next move.

I really enjoyed teaching this topic as much as the students enjoyed learning it, and it has earned its place in the Year 9 scheme of work for next year. (HW)

DEVELOPING ORACY SKILLS

In this Insider's Guide, **Hena Shah** and **Alan O'Donohoe** introduce Trinity Talks, a concept for teaching oracy skills in computing

There is a compelling case for prioritising oracy skills at secondary school. Spoken-language skills are amongst the best predictors of a child's opportunities in their adult life, but all too often, students are not given the opportunity to practise and develop these crucial skills. Voice 21, the UK's oracy education charity, for example, published a report in 2016 which uncovered a need for "resources and professional development for oracy in the UK" (helloworld.cc/voice2016). In this Insider's Guide, we discuss what the research says about the importance of spoken language skills and introduce Trinity Talks, a concept for teaching oracy skills in computing.

Why oracy matters

Research acknowledges that while oracy in the classroom will vary within different subjects, all subjects should be held accountable to rigorous and high standards of both teacher and student oracy within their discipline (Michaels et al., 2008). Talk can therefore be considered from a subject-specific perspective, or more generally as a pedagogy. There is a compelling argument for the benefits of an oracy education.

GROUND RULES FOR TALK

Set ground rules for classroom talk, offering students clear success criteria. These are more powerful if you write them with students themselves! Here are some examples:

- Invite others to contribute
- Try to come to a shared agreement
- Show active listening
- Consider giving students specific speaking roles; Voice 21 suggests the roles of instigator, builder, challenger, clarifier, prober, and summariser, with each having specific rules of interaction

Supporting cognitive development

By verbally building on others' explanations, and by acknowledging, clarifying, elaborating, and connecting ideas, students can begin to construct complete ideas and opinions. By questioning the basis of another's thinking, students actively engage in and monitor their own learning, deepening their understanding of concepts (Gaunt, 2018). In fact, the Educational Endowment Foundation (EEF) ranks metacognition and self-regulatory practices as among the most effective for students, adding on average seven additional months of progress in terms of academic attainment (EEF, 2024).

Supporting academic attainment

The link between oral language skills and broader academic attainment has been frequently highlighted in academic research. Benefits include supporting vocabulary acquisition and greater retention of subject-specific knowledge. These benefits are not strictly confined to disciplines traditionally associated with discussion, such as humanities and arts, but can be felt across all areas of the curriculum. To support students to transfer these skills across disciplines, a consistent approach must be adhered to.

Empowering students beyond the classroom

The advantages of high-quality classroom dialogue extend beyond the classroom in supporting the development of students' confidence and self-esteem and their ability to handle stress.

Gaunt and Stott passionately assert that, "Creating a space in which students can express their ideas and know that these will be listened to and valued, sends a powerful message to those young people we teach" (Gaunt & Stott, 2018).

Broadly speaking, then, an education which focuses on students' voices contributes towards shaping thoughtful and reflective citizens of wider society.

Research has consistently shown that competency in verbal communication is highly sought after by employers, and is

Students need opportunities to practise and develop spoken-language skills

commonly noted to be lacking in school leavers. In 2015, almost half of British employers reported concerns with the communication skills of young people entering the workplace (Pearson, 2015).

Some may assume that teaching to promote oracy means fabricating formal, high-stakes, presentation-style situations. In reality, the situations in which one speaks across a lifetime are incredibly varied. By neglecting to promote oracy, schools run the risk of neglecting to equip students with the interpersonal and communication skills needed to thrive in the everyday, modern workplace.

Establishing expectations

In order for successful oracy-led activities in the classroom, students must be taught how to use spoken language effectively; the teacher cannot assume that students have an understanding of what makes an effective discussion. While there is no 'magic bullet', Alexander (2008) emphasises the importance of certain factors that can help teachers to make classroom talk more effective, including:

- Setting clear ground rules and expectations for talk in lessons with their pupils
- Modelling the talk they expect from pupils
- Scaffolding pupils' interactions and responses
- Giving students feedback on what they say and how they say it

> "SET GROUND RULES FOR CLASSROOM TALK, INCLUDING CLEAR SUCCESS CRITERIA

Research into practice

At Trinity Academy Halifax in the UK, our aim is to make every student a confident speaker and to offer wider cultural opportunities to improve their oracy and cultural capital. It is part of the success criteria of the Phase One graduation that each student must take part in at least four of the seven Trinity Talks events across the year.

Each Trinity Talks week will take a different format and focus on a different spoken-language skill. A week of the curriculum is dedicated to Trinity Talks.

Year 7 and Year 8 (ages 11–13) follow the same format. This is to give students a varied diet in their oracy provision and expose them to different ways of communicating verbally. By the time students complete Year 8, they will have had 16 opportunities to practise different spoken-language skills.

Our success criteria and feedback are very much modelled on the oracy benchmarks determined by Voice 21.

To help students present successfully, teachers and mentors can model different presentation styles

> ALL SUBJECTS SHOULD BE HELD ACCOUNTABLE TO HIGH STANDARDS OF ORACY

FURTHER READING

Alexander, R. (2008). Towards Dialogic Teaching: Rethinking Classroom Talk, Fourth Edition, York: Dialogos UK (39)

Education Endowment Foundation (EEF) (2016). Meta-Cognition and Self-Regulation, **helloworld.cc/metacognition**

Gaunt, A. and Stott, A. (2018). Transforming teaching and learning through talk. Rowman & Littlefield Education

Michaels, S., O'Connor, C., and Resnick, L. (2008). Deliberative Discourse Idealized and Realized: Accountable Talk in the Classroom and in Civic Life, Studies in Philosophy and Education, 27 (4), 283–297

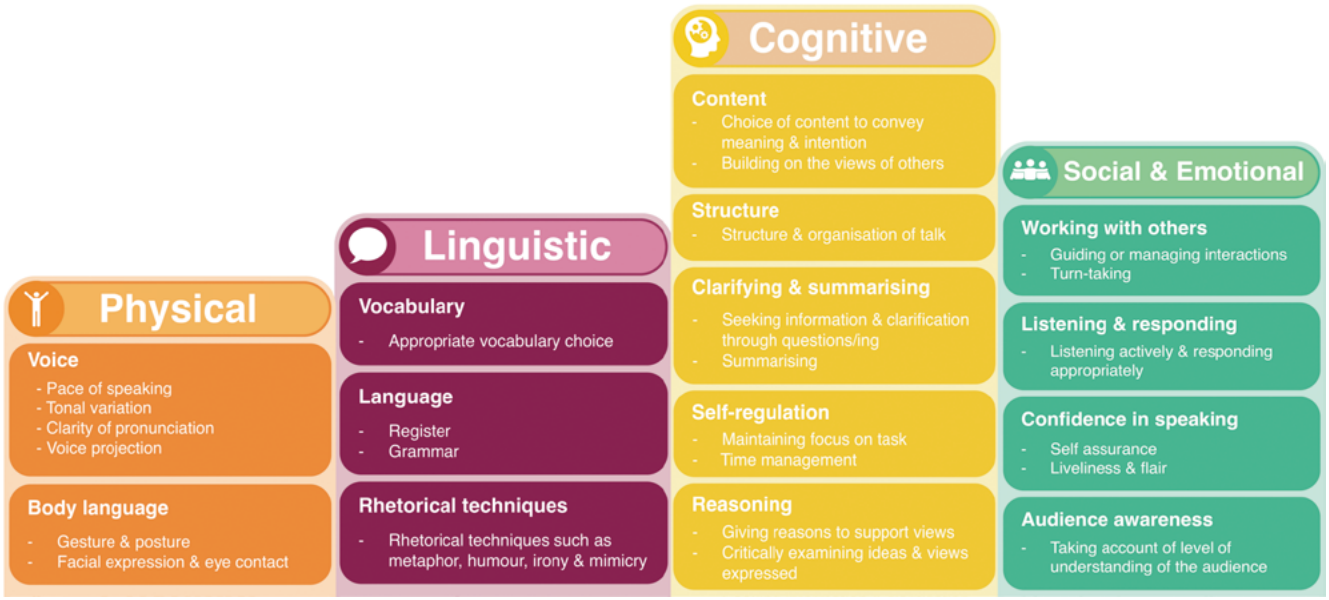
Pearson (2015). Inspiring Growth: CBI/Pearson Education and Skills Survey 2015, London: CBI (36)

Developing oracy skills in computing

Hena, director of computing and enterprise (Trinity Multi-Academy Trust West Cluster), met with the former lead teacher for whole-school literacy, Holly Frazer, to discuss what Trinity Talks 2022–23 would look like in computing. They agreed that students should have the opportunity to deliver a verbal presentation on a computing hero of their choice.

To model best practice for delivering an effective spoken language presentation, Hena suggested they contact Alan O'Donohoe, who is a specialist leader in education for Exa. They met with Alan virtually to discuss the research behind Trinity Talks and the long-term aims of the programme, and then discuss the practicalities of what it could look like in computing. They agreed that Alan would present to an entire year group about three computing heroes. For each presentation, he would lean on different spoken-language skills to model the various ways in which students might choose to present successfully. Throughout the presentation, Alan would take pauses from the presentation to explain why he had made the presentational choices he had, and the effects they had on the audience.

Following this launch event at the start of the week, students went on to write their own presentations on a computing hero. Within the lessons, reference was made to Alan's model of best practice. It was made clear to students that the emphasis lay on the spoken-language skill of presenting to an audience, rather than researching their hero. As such, students were provided with a



The Oracy Framework by Voice 21, the UK's oracy education charity

succinct information pack on various computing heroes to use in their presentation.

Following a planning and rehearsal lesson, students then presented to their class. They received feedback from their peers and teachers in line with the adjusted Voice 21 oracy benchmarks.

The students who exemplified best practice in each class, based on their presentation scores, were then put forward to take part in a coding workshop. To celebrate their success, Alan was invited back to deliver a half-day workshop on how to use a Raspberry Pi to demonstrate logical thinking and problem-solving in Minecraft using the text-based programming language Python. Throughout the afternoon, students customised and created their own individual programs. Students were also demonstrating key skills which allowed them to work towards a final prize of the day. We had a total of five winners in Years 7 and 8, and Trinity students were extremely excited as they received their own Raspberry Pi.

This is the second academic year that Trinity Talks has run, and therefore the first time that a Phase 1 cohort have completed both years of the programme. Students and staff are becoming familiar with the format and purpose of the talks. As a next step, we hope to keep expanding the programme to further department areas and also to other schools across our multi-academy trust (a group of schools that work in partnership with each other). To continue to raise the profile of oracy in the classroom, we hope that the experience of delivering Trinity Talks also gives staff a place to practise facilitating effective student oracy in the classroom, and that this encourages further opportunities for extended conversation across the curricula. As a next step, we hope to reflect on our curricula more thoroughly, to determine where other opportunities exist to practise spoken-language skills. (HW)

HENA SHAH

Hena Shah serves as the director of computing and enterprise for Trinity Multi-Academy Trust. With a wealth of experience in computing leadership, media, and business strategy, she excels at driving innovation and fostering growth across all levels, from ITTs to middle leaders. Hena is committed to advancing digital transformation and empowering teams to thrive in a digital landscape (**@Henashahh**).

ALAN O'DONOHOE

Alan has over 20 years' experience teaching and leading technology, ICT, and computing in schools in England. He runs **exa.foundation**, delivering professional development to engage digital makers, support computing teaching, and promote the appropriate use of technology (**@teknoteacher**).

KEEPING HUMANS IN THE LOOP

Michael Conterio and **Dr Tracy Gardner** discuss how, in a world of increasingly automated systems, humans are still needed

Imagine trying to judge the age of a young person at the cinema, to decide whether they are able to view a film with a particular age rating. This is a task that could be performed by an AI system using facial recognition technology. You could use this scenario in a lesson, to get learners thinking about when a human should be involved in a decision. How would they feel if a computer insisted that they were under age when they were actually old enough to see the film? Why is it important to make sure that decisions aren't fully automated? How and when would you involve a human in the process?

And where did that age rating come from in the first place? In a previous column, we discussed the idea of systems thinking (**helloworld.cc/22**). Using this approach, you could consider a wider age-rating system, that includes the film rating board and the influences of society. Although films are currently rated by humans, is this a job that an AI model could do? Who would decide what data to use to train it? What biases could this entrench in the model?

Although the impact of this example might seem minor (perhaps not to your students!), there are many other situations where it might also be necessary to keep a human in the loop. This phrase is commonly used in machine learning to refer to actively involving a human during the training of a model. In military matters, 'human in the loop' is used to describe some autonomous weapons systems — with a final decision being taken by a human. Similarly, the phrase can also apply to involving humans during the operation of an AI system, particularly when confidence in the result is low or the stakes of the decision are high.

Discussing humans in the loop

Human oversight can help to mitigate any biases present in the AI model, especially as human opinions change over time. For example, the original *Mary Poppins* film has recently been reclassified because our ethical standards have progressed (**helloworld.cc/MaryPoppins**). If humans are not kept in the loop, there's a risk that we won't actively revisit the data that an AI system is trained on.

What responsibilities does the human in the loop have? People often treat decisions made by computers as being more accurate and logical than those made by humans, for example by blithely following directions from a satnav that take them into unsafe situations. How can we protect against the human effectively removing themselves from the loop in this way, by accepting a computer's output without questioning it?

In the UK, the GDPR laws on data protection give us the right to have a human involved in significant decisions such as those that affect our legal rights and "other equally important matters" (**helloworld.cc/decisionrights**). It's important that young people understand their rights when they are interacting with machine learning systems. If they go on to develop automated systems, they will also need to know about their responsibilities as creators of these systems.

Keeping yourself in the loop

With machine learning and AI models still at a relatively early stage, it's important to recognise that you and your students are all part of a larger system that includes AI — that is, our society. This means that we too can act as humans in the loop, carefully evaluating when and how to use AI models and the outputs they produce. What level of responsibility do we all have in using, or even in creating, AI models? (HW)

TRACY GARDNER & MICHAEL CONTERIO

Tracy is a computer scientist, tech industry professional, and technology educator, and a co-founder of Flip Computing. Michael is a former physicist and now works as an online course production manager at the Raspberry Pi Foundation.

BEBRAS PUZZLE SOLUTION:

BEAVERS VS. KANGAROOS (PAGE 69)

The correct answer is c — exactly six kangaroos can pass Fred.

All beavers except Fred can be ignored for now, because they are willing for Fred to let one kangaroo pass. This could happen:

1. The kangaroo jumps onto the stone.

2. Fred goes forward two steps.

3. The kangaroo jumps back to the log path and can continue forward.

4. Fred goes back two steps to give another kangaroo the possibility of jumping to the stone.

By executing this sequence of steps five times, Fred can let five kangaroos pass by going back ten steps in total. Then one more kangaroo can pass, because Fred will then be in his initial position again. So, a total of six kangaroos can pass if Fred takes a step back ten times.

This can be expressed by a mathematical formula. If Fred wants to let k kangaroos pass, he will have to walk $s = 2 \times (k - 1)$ steps back.

A general expression for the number of kangaroos k is:

$$k = 0.5 \times s + 1$$

THE COMING WAVE

A new book looks at the risks of fast-growing technologies in AI and biotech

INFO **BY** Mustafa Suleyman with Michael Bhaskar | **PUBLISHER** Crown | **PRICE** $32.50 | **ISBN** 9780593593950 | **URL** helloworld.cc/the-coming-wave

Petar Simonovic

Protein folding was a grand challenge of biology, says Mustafa Suleyman, DeepMind co-founder and CEO of Microsoft AI. It held back fields ranging from medicine to plastic-eating enzymes — until DeepMind unveiled its AlphaFold AI system in 2018. A "hidden universe of proteins was revealed," Suleyman says. One of biology's hardest problems was, suddenly, "ticked off the list".

AlphaFold is, according to Suleyman, "a perfect example" of the speed of progress in AI and biotech. In *The Coming Wave*, co-written with Michael Bhaskar, he warns that these technologies, combined with quantum computing and robotics, will transform both society and "what it means to be human".

Suleyman examines historical waves of innovation, from the Stone Age to the Information Age, arguing that technology always proliferates until it's commonplace. We carry the internet in our pockets.

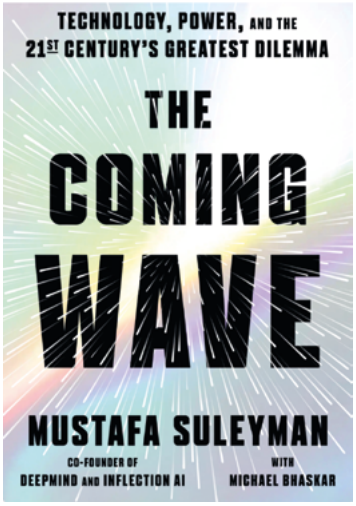
What sets this new wave apart is the sheer potential to help and harm. The "terrible bind", says Suleyman, is that these technologies can solve existential threats such as climate change, yet they themselves pose existential threats.

AI and biotech promise unprecedented wealth and surplus. But they could, Suleyman argues, usher in a world in which "post-humans" engineer themselves into an "unreachable intellectual or physical plane", lone terrorists control swarms of lethal drones and powerful techno-dictatorships eclipse history's most extreme totalitarian governments. Will we have jobs when robots as cheap as microwaves staff hospitals, pick fruit, and wait tables? We can't all become prompt engineers.

Containment is, the book argues, the only solution. Regulations, treaties, and incentives could slow adoption so we can reap the benefits and limit the harm. Containment is, however, likely to be impossible. Nuclear weapons are the sole technology that we have curtailed, but only because we understood their power. If we fail to understand this wave, it could mean that "humanity will no longer be at the top of the food chain".

Suleyman acknowledges that some of the scenarios presented are firmly speculative. He dismisses the "colossal red herring" of the singularity and "tired tropes of Terminators". Yet it's often difficult to separate plausible outcomes from outright outliers.

The book does, however, present its argument with accessible content on the tech it covers, aimed at a wide readership. That argument is strongest when, instead of looking into the future, it surveys the present.



ChatGPT-3, launched in 2020, was the largest ever neural network, a hundred times bigger than its predecessor, but its size is now nothing out of the ordinary. Human genome sequencing cost $1bn in 2003, but had plunged below $1,000 by 2022 — a millionfold drop. Genetic engineering kits (live frogs included) are $1,999, while a DNA synthesiser costs $25,000. You can use it as you wish, Suleyman says, "without restriction or oversight".

It's in these facts, not in the imagined nano-bot swarms, that we can glimpse the potential of these tools and sense that they could slip beyond our control. (HW)

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